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Use of Banana Peel As A By-Product to Increase The Nutritive Value of The Cake

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ABSTRACT

The aim of this study was to demonstrate the nutritional value of banana peel powder (BPP) by highlighting its antimicrobial and antioxidant material. Additionally, to use the (BPP) as a low-cost substitute for wheat flour in a cake. Additionally, the findings of BPP at various concentrations (3,6,9,12, and 15%) were compared to some critical quality properties such as physical, chemical, and microbial properties, as well as the sensory characteristics of cake. The present findings indicate that more than 50.7 percent of the total weight of the banana fruit as waste can be used as a good source of macro and micronutrients, antimicrobials, and antioxidants in food processing. Additionally, the BPP is considered a good source of protein (15.10%) and ash (25.19%).The real amount of partially substituted cake BPP steadily decreased as the BPP concentration increased. The replace of wheat flour for BPP resulted in significant amounts of natural antioxidants being added to the cake production process, especially in samples substituted at levels of 12 and 15% BPP, which have a variety of beneficial effects on human health and act as an antimicrobial to extend the shelf life of the cake product. The organoleptic consistency attributes of cake revealed a marginally important difference between the control sample and those containing BPP up to6%for all organoleptic properties measured and also designated as excellent when compared to the control sample. As a result of this discovery, it is recommended that BPP be used up to 15% to complement and improve the quality attributes of cakes, at a level that has numerous health benefits.

***Keywords*: Banana peel, Cake, Substitution

INTRODUCTION

Many agricultural wastes by-products that are discarded produce phenolic that can be used as antioxidants and preventative agents against some diseases. Recent research has proposed the use of fruit and vegetable by-products as natural food additives due to their high content of polyphenols, carotenoids, and other bioactive compounds (Ayalazavala *et al.*, 2011; O'shea *et al.*, 2012).

Agro waste refers to the vast quantities of solid waste produced during the processing, preparation, and consumption of fruits and vegetables. These wastes can create disposal and pollution issues, as well as deplete valuable biomass and nutrients. Agro wastes have the ability to be converted into usable goods or even raw materials for other industries (Pazera *et al.*, 2015).

Utilizing wastes from the production of fruits and vegetables as a source of functional ingredients is a promising area (Schieber *et al.*, 2001). Additionally, waste management has become a necessity as a result of strict national and international legislation. The food industry will face significant challenges, including minimizing waste produced during processing operations, using by-products, and treating and disposing of wastes while maintaining sustainable output.

Bioconversion of agro wastes is receiving increased attention regarding the fact that these matters represent a possible and utilizable resource for conversion into useful products (Martin, 1998). Functional foods contain bioactive ingredients linked to the physiology of the health benefits of benefits associated with the prevention and management of chronic diseases. All foods containing bioactive ingredients are considered functional due to their connection with the physiological health benefits associated with the prevention and management of numerous chronic diseases, such as type 2 diabetes (Alkhatib *et al.*, 2017).

The banana fruit is composed of two parts: the peel and the pulp. The peel, which is the fruit's primary by-product, accounts for approximately 40% of the fruit's total weight. Until recently, banana peels served little purpose and were discarded as waste, generating large quantities of organic material that must be handled (Sheikh *et al.*, 2017). Since researchers began examining the chemical composition of banana peels, many potential applications have arisen (Agama *et al.*, 2016).

Banana peel is a mineral, bioactive compound, and dietary fiber powerhouse (Kusuma *et al.*, 2018). Numerous studies have shown that banana peel powder (BPP) can be used as a functional food source. Banana peels are high in phenolic compounds, which act as antioxidants, protecting against heart disease and cancer (Someya *et al.*, 2002).

Natural bioactive components present in by-products can be used to enhance the nutritional properties of bakery products. Consumer acceptance of bakery items such as sponge cakes suggests that they may be used to inject bioactive compounds into the human diet (Moraes et al., 2010). While cakes, unlike bread, are not considered

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essential foods, they are embraced and eaten by people of all ages (Borges *et al.*, 2006).

The aim of this study was to shed light on the nutritional quality of banana peels powder (BPP) in terms of its mineral, antimicrobial, and antioxidant material.

Additionally, to incorporate banana peels powder (BPP) as a low-cost substitute for wheat flour in the manufacture of cakes. Additionally, the effect of incorporating banana peels powder (BPP) at various concentrations (3, 6, 9, 12 and 15%) on several critical cake quality properties such as physical, chemical, and microbial properties, as well as the effect of incorporating banana peels powder (BPP) on sensory attributes of the cake made.

MATERIALS AND METHODS

Materials

Raw materials:

Wheat flour:

Wheat flour (72% extraction) was obtained from the south Cairo mills company, Cairo government, Egypt.

Additives materials:

Sucrose, butter, fresh eggs, skim milk powder, baking powder, vanilla powder, water and crude cacao, used in preparing the cake dough. These materials were obtained from the local market, Cairo, Egypt.

Preparation of banana peels powder (BPP):

27 kg of ripe bananas (*Musa Cavendish*), a variety of (Williams), were purchased in April 2019 from local markets in Cairo, Egypt. The bananas were washed to remove dirt, the peels were removed from the pulp, and the peels were weighed to determine their total weight as food processing waste (13.5 kg wasted 10 kg wet peel). Banana peel accounts for about 50.7 percent of the overall weight of fresh bananas. After cutting the peels into small pieces (approximately 2.5 cm), they were dried for 48 hours at 45°C. It grinds and weighs until the drying process is complete (10 kg wet peel formed 0.5 kg powder (BPP) and packed in plastic bags and placed at -18 °C in a deep freezer until further treatments.

Reagents:

All solvents, chemicals, and reagents used in this analysis were of analytical grade, and all pure standards and fatty acids methyl esters were obtained from El-Gomhouria Trading Chemicals and Drugs in Cairo, Egypt.

Methods

Preparation of cake samples:

Cake preparation ingredients were purchased from commercial sources and the Raeker and Johnson (1995). Approved methods were slightly altered for cake preparation. To make dry cake ingredients were mixed except sugar. The butter and supplemented materials BPP were mixed by using mixing machine at a medium speed for 3 min, then sugar was added to the mixture and beaten for 3 min, and also the beaten eggs and vanilla were added then beaten for 2 minutes, and affixed to the creamed fat-carbohydrate mix and easily beaten at low speed for 5 transactions. Wheat flour (WF) and other ingredients were added to the previous blend gradually and beaten for 5 minutes. Thirty grams of cake were scaled into the greased mug and cooked at 180°C for 25 minutes in a preheated oven. The resulting cakes stayed 2 hours for chilling. Next, packed in polyethylene packages and stored in the refrigerator (4°C) until formula analyses are shown in Table (1).

Physical and Chemical analysis:

The weight (g) for cake was determined individually within one hour after baking the verage was recorded. Both volume (cm3) and specific volume were determined and cake density was calculated according to Türker *et al.,* (2016). Cakes were weighed in grams (g) using analytical balance. The volume (cm3) of produced cakes was determined by rape seeds displacement. Specific volume was calculated using the following equation:

Specific volume = Volume (cm3)/Weight (g).

Table 1. Amount and percentage of ingredients used in processing of cake samples at different replacement levels of banana peels powder (BPP).

Ingredients (g)	Amount and percentage of ingredients at different replacement levels					
	Cake (Control)	Cake with BPP				
		3% BPP	6% BPP	9% BPP	12% BPP	15% BPP
WF (72%)	100	97	94	91	88	85
BPP	0	3	6	9	12	15
Sucrose	60	60	60	60	60	60
Butter	50	50	50	50	50	50
Fresh whole egg	35	35	35	35	35	35
Skim milk powder	7	7	7	7	7	7
Cacao	4	4	4	4	4	4
Baking powder	4	4	4	4	4	4
Vanilla	1	1	1	1	1	1
Water (ml^3)	35	35	35	35	35	35
Total Ingredients	296	296	296	296	296	296

WF: Wheat flour (72%) BPP: Banana peels powder

Was used to determine equation was used to determine the density of the cake: Density (g/cm3) = Mass (g) x Volume (cm3) (cm3). Moisture, protein (N5.7), ether extracts, ash, and fiber content of tested samples were calculated in according to AOAC (2016). Mir *et al.* (2017) was determined the color. L*, a*, and b* color scales measured with a Hunter Lab optical colorimeter (Model D25M, Hunter Associates Laboratory, Reston, USA). Prior to color measurement, calibration with black and white standards was performed. The pH value was measured using an electric pH meter (Consort C 3010 Poland) in depending on AOAC (2016). Standard procedures Carbohydrates in total were measured using the difference method.

Total carbohydrates (%) = 100 - (% moisture + % crude protein +% fat + % ash).

Minerals contents were determined in banana peels powder (BPP) according to the standard method of AOAC, (2016), by using atomic absorption spectroscopy technique (GBC, Model 932AA, Australia).

Energy values:

The energy value was calculated as equation (cal/100g^{-1}) of Anvisa, (2001). i.e., energy value, cal/100g = [(4 × % protein) + (4 × % carbohydrate) + (9 × % total lipids)].

Amino acids profile:

The optimal experimental conditions for hydrolysis have been determined by varying the temperature, time, and hydrolyzing reagent. Separation and quantitative analysis of the by-products were carried out according to the method defined by using an HPLC instrument (GBC, Germany) fitted with a dual pump and a UV-VIS detector and a C18 column (5 m particle, 125 mm x 4 mm). Chrome software was used to process the chromatographic data (version 3.1). UV spectroscopy and analysis. The amino acid sequence of a protein is compared to the ideal protein pattern suggested by the Food and Agriculture Organization (FAO) (Campanella et al., 2002).

Determination of Natural Antioxidant:

Total phenols content:

The total phenols content of banana peels powder (BPP) was determined spectrophotometrically using the Folin Ciocalteu reagent assay with gallic acid According to Vu et *al.*, (2018).

Total flavonoids content:

Total flavonoids content were analyzed according to the method described by Mathur and Vijayvergia, (2017).

Total Carotenoids content:

Total of carotenoids content were analyzed based on the method and the guideline of Rodriguez (1999).

Carotenoids profile:

The absorption spectra of carotenoids extracts in n-hexane were determined using a UV-Vis spectrophotometer (UV 1700, Shimadzu, Kyoto, Japan). The equation used by Gross (1991) was used to calculate the total concentrations of carotenoids.

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Determination of Antioxidant Activity:

Yen and Duh (1994) identified the extract's antioxidant activity as DPPH-dependent free radical recovery. We prepared a fresh (0.004 percent w/v) methanol solution of the radical 1,1-diphenyl-2-picrylhydrazyl (DPPH) and stored it in the dark at 10 °C. Methanol has been used to remove the sample. Three milliliters of DPPH solution was added to a 40-liter aliquot of methanol solution. Using a transparent UV spectrophotometer, the absorbance values were immediately recorded (Milton Roy, Spectronic 1201). We conducted continuous measurements of the decrease in absorbance at 515 nm, collecting data at 1-minute intervals before the absorbance stabilized (16 min).

Additionally, we measured the DPPH radical's absorbance in the absence of an antioxidant (control) and in the presence of the reference compound ascorbic acid. All measurements were made three times and the mean was measured. The percentage inhibition (PI) of the DPPH radical was calculated using the following formula:

Anti-radical activity (%) = (control absorbance - sample absorbance) × 100/control absorbance.

Total Antioxidant Capacity (TAC):

The Total Antioxidant Capacity (TAC) was estimated according to the method Prieto *et al.* (1999). A total of 0.2 mL of methanol sample solution was mixed with 0.1 mL of reagent solution (0.6 M sulphuric acid, 2 mM sodium phosphate and 4 mM ammonium molybdate). The mixture was incubated at 95 °C for 90 minutes in a thermal block. After cooling the samples, their absorbance at 695 nm was determined. The TAC was calculated using the standard tochopherol graph (as mg equivalents tocopherol 100g sample).

Microbiological analyses:

Complete bacteria, molds, and yeasts were counted in generated cake samples after 0, 3, 6, 9, and 12 days of room temperature storage; all experiments were performed in triplicate. Complete plate bacterial counts were calculated using the plate counts technique on nutrient agar medium, as defined in Manual (1984). For 48 hours, the plates were incubated at 37 ºC. Mold and yeast counts were determined using potato-dextrose agar medium. For five days, the plates were incubated at a temperature of 20-25ºC for 5 days. Coliform bacteria were identified by performing a presumptive test using Mac-Conkey broth and incubating at 35-37 °C for 24-48 hours (Murray *et al.,* 2007).

Sensory evaluation:

Salama *et al.* (2013) described a method for determining the quality of fresh cakes after baking; cake samples were allowed to cool at room temperature for 3 hours (25 C). Following that, the cake was cut with a sharp knife and inspected by a panel. Sensory characteristics include a general appearance score of (20), a crust color score of (10), a crumb color score of (10), a crumb texture score of (20), a flavor score of (20) and a taste score of (20) and total score (100). Excellent (86–100), very good (76–85), Good (75–61), and Poor < 61.

Statistical Analysis:

As defined by Tieland *et al.,* (2017) one-way analysis of variance (ANOVA) with SPSS (version 16) and the significant difference test (ANOVA) Duncan's multiple range tests were also used in SPSS to quantify significant differences between mean values at the 5% level (version 16).

RESULTS AND DISCUSSION

1- Chemical composition of wheat flour and banana peels powder (BPP):

The following table summarizes the chemical composition and energy content (cal/100g) of banana peels powder (BPP) (2). The sample's mean percentage moisture content was determined to be 10.03 %. High moisture content in foods or processed goods indicates their freshness and shelf life, as well as increased activity of water soluble enzymes and coenzymes needed for metabolic activities, exposing food items to increased microbial spoilage and a shorter shelf life, which can result in their deterioration (Adepoju and Adeniji, 2008). When compared to other plant protein sources, the banana peels powder (BPP) samples contained a comparatively large amount of crude protein (15.10%). Protein is a critical component of the diet necessary for animal and human survival; their primary role in nutrition is to provide a sufficient supply of required amino acids. Since the crude fat content of the banana peels powder (BPP) sample was 7.04 %, it can be a good source of fat-soluble vitamins and contribute significantly to the energy content of foods. The sample contained 25.19% ash, which was significantly higher than the 0.50-4.40 % ash content previously recorded for agricultural hull (Adebowale and Bayer, 2002). The high ash values indicate that the peels are rich in minerals (particularly macro minerals). Carbohydrate content was 44.64 % in the samples, indicating a good source of energy. Carbohydrates are a significant class of naturally occurring organic molecules. The energy content of banana peels powder (BPP) was determined to be 302.32 calories per 100 grams. The banana peels powder (BPP) had a PH of 5.71. These findings corroborate those of Leite *et al* (2011).

Table 2. **Chemical composition of wheat flour and banana peels powder (BPP) (on dry-weight basis).**

Chemical composition	Samples tasted	
	WF (72%)	BPP
Moisture%	10.94^a±0.18	10.03^b±0.17
Crude Fat%	1.58^b±0.07	7.04^a±0.08
Crude Protein%	9.86^b±0.14	15.10^a±0.19
Ash%	0.89^b±0.07	25.19^a±0.12
Carbohydrates%	76.63^a±0.21	44.64^b±0.19
Energy (cal/100g)	360.18	302.32
PH	6.70	5.71

WF: wheat flour (72%) BPP: Banana peels powder(M±S.D) = Mean ± Std. Deviation. Values with different small letters in the same row are significantly different (p<0.05).

2- Minerals content of wheat flour and banana peels powder (BPP):

Agro-wastes are known to be mineral-dense on a micro and macro scale. Kapri *et al.,* (2020), and the findings obtained are summarized in Table (3). The mineral composition of banana peels powder (BPP) is described in Table (3). Phosphorus, sodium, iron, and calcium were abundant in the banana peels powder (BPP), but sulfur, manganese, potassium, and copper were deficient. Thus, banana peels powder (BPP) contains significant amounts of iron, calcium, and phosphorus. Calcium (70.38 mg/100 g) and phosphorus (204.15 mg/100 g) are critical for the development of strong bones and teeth, as well as for growth, blood clotting, heart function, and cell metabolism, respectively (Roth and Townsend, 2003 and Rolfes and Paar, 2009). Calcium is needed for intracellular processes in insulin-responsive tissues such as skeletal muscle and adipose tissue. Calcium flux changes can have a detrimental effect on insulin secretion, which is a calcium-dependent mechanism (Connell, 2001). The potassium level of the banana peels powder (BPP) 454.41 mg/100 g. It is an essential element that helps in the development of the body and muscle. The iron level of banana peels powder (BPP) was recorded 83.00 mg/100g. Iron is an essential component of hemoglobin and it is critical to the proper functioning of the immune system and the production of energy (Chen *et al.*, 2010). The magnesium content was found to be 41.88 mg/100 g in banana peels powder (BPP). The zinc level was found to be 35.04 mg/100 g for the banana peels powder (BPP). Zinc plays a key role in the regulation of insulin production by pancreatic tissues and glucose utilization by muscles and fat cells (Eleazu *et al.,* 2013). The level of copper was found to be 5.60 mg/100 g for the banana peels powder (BPP). Copper is present in all living organisms and is necessary element in chemistry of oxidation, growth and development. The composition of sodium in banana peels powder (BPP) was found to be 101.01 mg/100 g. Sodium helps in maintaining healthy fluid balance (Tisato *et al.,* 2010). The mean value of manganese determined was found to be 1.40 mg/100 g for the banana peels powder (BPP).

Table 3. Minerals content of Wheat flour (WF) and banana peels powder (BPP).

Minerals content	mg/100g		RDA (mg/ 100g)
	WF (72%)	BPP	
Ca	276.22^A±0.57	70.38^B±0.72	260
P	273.28^A±0.12	204.15^B±0.15	270
K	12.73^B±0.15	454.41^A±0.33	220
Na	530.77^A±0.05	101.01^B±0.32	70
S	130.0^A±0.27	0.10^B±0.09	-
Fe	13.05^B±0.11	83.00^B±0.13	35
Mn	0.72^A±0.09	1.40^B±0.23	3
Zn	2.5^B±0.82	35.04^A±0.74	3
Cu	0.55^B±0.10	5.60^A±0.56	0.9
Mg	346.61^A±0.26	41.88^B±0.82	170

WF: Wheat flour BPP: Banana peels powder

RDA: Recommended Dietary Allowances Food and Nutrition Board, (1989) (Ramirez-Orduna et al. 2005). (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same row are significantly different (p<0.05).

3- Natural antioxidants content of banana peels powder (BPP):

Antioxidants are essential for the preservation of food against oxidative degradation and for the conservation of unsaturated lipids in animal and human tissues. Thus, the incorporation of essential oils into foods, which may act as natural antioxidant preservatives, may increase the shelf life of related food products while also having an effect on consumer health (El- Waseif and Badr, 2018).

Natural antioxidants such as phenols, carotenoids, and flavonoids are found in abundance in the plant kingdom and have a variety of biological functions, including antioxidative action. The collected data are summarized in Table (4).

Table 4. Natural antioxidants content of banana peels powder (BPP) (mg/100g).

Natural antioxidants content		BPP
Total Flavonoids (mg/100g)		1783.32
Total Carotenoids (mg/100g)		846.58
Carotenoids (mg/ml)	Luteolin	5.33
	Alpha-carotenoids	42.19
	beta-carotenoids	27.23

BPP: Banana peels powder

From the obtained data (Table 4), showed that the total phenols and total flavonoids were highest concentration of the natural antioxidant contents of banana peels powder BPP (1210.20 and 1783.32 mg/100g on a dry weight basis, respectively), while total carotenoids content were 846.58 mg/100 g. The results were relatively comparable with the data given by Leite *et al.,* (2011).

Coyne *et al*., (2005) demonstrates a significant association between vitamin A-rich carotenoids and diabetes status. According to these investigators higher blood glucose levels, as well as higher fasting levels of insulin, were observed in study participants with lower level of carotenoids. Carotenoid levels also decreased as the severity of glucose intolerance increased. These findings suggest that banana peels which rich vitamin A and carotenoids might help diabetics to manage their condition.

Generally, it can be announced that the addition of banana peels powder ((BPP) to food products will be led to increasing amounts of natural antioxidants, so this addition will cause the prolongation of its shelf-life as well as the maintenance or enhancement its original quality properties of foods containing the banana peels, beside healthy beneficial functions to food consumption.

DPPH Scavenging% of banana peels powder (BPP) extract:

The higher activity of DPPH radical scavenging activity may be attributed to the presence of higher levels of total phenolic and flavonoids as they play a key role as proton-donating ability and could serve as free radical inhibitors or scavengers, acting possibly as primary antioxidants (Fransisco and Resurrection, 2009 and Ghasemzadeh *et al.*, 2010).

As shown in the obtained results Table (5), it could be noticed that inhibitory concentration at 50% (IC_{50}) for banana peels powder (BPP) was high value due to the higher content of total phenol compounds (Table 4). The oxidation reactions for foods and drugs can be inhibited by using antioxidants that are associated with free radicals and reactive molecules Lee *et al*, (2010).

Banana peels powder (BPP) extract has been shown to have antioxidant efficacy and based on the results of the antioxidant ability test, the inhibitory concentration at 50% (IC_{50}) value for DPPH scavenging activity of banana peels powder (BPP) extract can be summarized at 2.297 µg/mL. It is better to mention that a lower inhibitory concentration at 50% (IC_{50}) value represents more potent free radical inhibitory activity. The strong antioxidative properties of banana extracts could be attributed to the presence of different antioxidant components Mrvcic *et al.*, (2012).

Table 5. DPPH Scavenging % of banana peels powder (BPP) extract.

	DPPH Scavenging %												
Conc. µg/ml	**1000**	**500**	**250**	**125**	**62.5**	**31.5**	**15.75**	**7.8**	**3.9**	**1.95**	**0.975**	**0.487**	**IC_{50} µg/ml**
BPP	97.0	95.0	90.0	81.0	71.0	66.5	61.0	56.7	53.2	47.5	46.2	45.0	2.297

BPP: Banana peels powder **IC_{50}: inhibitory concentration at 50%**

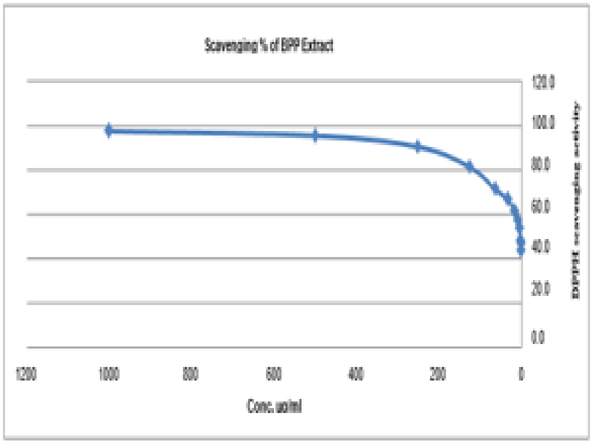

Fig. 1. DPPH Scavenging % of Banana peels powder extract

Amino acid composition of banana peels powder (BPP):

The nutritional protein quality of banana peels powder (BPP) was determined by comparing its IAA content to the FAO/WHO (1973) as shown in Table (6).

As shown in Table (6), banana peels powder (BPP) contained an abnormally high concentration of aromatic amino acids (phenylalanine and tyrosine), lysine, and leucine, all of which are typically deficient in most foods.

To determine essential amino acids, banana peels powder (BPP) was used. Leucine, Phenylalanine, Lysine, and Arginine were the most abundant essential amino acids (Table 6). Banana peels powder (BPP) contains nine out of ten essential amino acids, which is equivalent to the essential amino acids found in other foods, such as corn (nine essential amino acids) and wheat (nine essential amino acids) (El-Shafei *et al.*, 1983). (Mcelroy *et al.*, 1949). The protein from banana peels powder (BPP) can be considered to have a high biological value, as it contains almost all of the amino acids identified by Lee *et al* (2019). Thus, the incorporation of locally available banana peels powder (BPP) into cake and other foodstuffs, especially those deficient in aromatic amino acids (phenylalanine and tyrosine), lysine, leucine, and isoleucine, has a significant economic value and a favorable outlook for food technology and human nutrition.

Generally, banana peels powder (BPP) is considered as good source of indispensable amino acids. The amino acids compositions of banana peels powders (BPP) were also investigated by Kim *et al.* (2012). Their results were relatively comparable with the present data.

Table 6. Amino acid composition of banana peels powder (BPP).

Amino acids	**BPP g/100g protein**	**FAO/WHO (1985) g/100g protein**
Threonine	2.82	4.7
Valine	2.01	6.6
Histidine	4.61	-
Tyrosine	1.97	6.0
Lysine	7.16	7.0
Methionine	2.52	6
Tryptophan	7.39	-
Phenylalanine	9.56	9.3
Isoleucine	9.50	5.4
Leucine	10.97	8.6
Total I.A.As	58.51	
dispensable amino acids (D.A.As)		
Asparagine	0	
Arginine	11.10	
Serine	8.26	
Glycine	7.32	
Alanine	8.51	
Cysteine	6.30	
Total D.A.As	41.49	

BPP: Banana peels powder

7- Proximate chemical composition of cake samples:

The chemical composition and energy content (cal/100g) of cake samples made with substituted flour containing varying amounts (3, 6, 9, 12, and 15%) of banana peels powder (BPP) are listed in Table (7).

As shown in the obtained results (Table 7), the protein and ash content of the cake produced increased significantly (P0.05) as the replacement level increased from 3 to 15% of banana peels powder (BPP), with values ranging from (13.53-17.80 %) and (2.46-3.79 %), respectively, in comparison to the control sample, which contained 13. In comparison to the control sample, fat was minimal and progressively increased as the replacement amount of banana peels powder (BPP) increased from 3 to 15% (15.00 - 16.37%). (Table 7).

Finally, it could be seen that as the levels of the banana peels powder (BPP) increased in cake formula, the caloric value was increased. These results may be due to a gradually *BPP:*

Increased of protein and fat as the results of replacement of banana peels powder (BPP). Generally, it could be concluded that cake containing the banana peels powder (BPP) had a good nutritional quality with regards protein and ash contents and this is means fortifies the product with essential substances, which amount insufficient in the daily diet (Al-Sayed and Ahmed, 2013)

Table 7. Proximate chemical composition of cake samples containing substituted flour with different levels of banana peels powder (BPP).

Samples	Chemical composition of cake samples %					pH	Energy (Cal/100g)
	Moisture	Total Fat	Total Protein	Ash Content	Total Carbohydrates		
Control	25.97^{A}±0.97	15.03^{A}±0.03	13.03^{A}±1.14	2.01^{A}±0.03	43.96^{A}±0.01	8.21^{A}±0.96	363.23^{A}±0.21
BPP 3%	28.27^{A}±0.98	15.00^{A}±0.30	13.53^{AB}±0.72	2.46^{A}±0.27	40.45^{B}±0.75	8.03^{A}±0.50	350.92^{B}±0.41
BPP 6%	22.33^{B}±0.87	15.50^{A}±0.10	14.20^{AB}±0.30	2.75^{A}±0.30	45.22^{AC}±0.35	7.83^{A}±0.88	377.18^{C}±0.56
BPP 9%	18.80^{C}±0.83	15.77^{A}±0.49	15.07^{ABC}±0.10	2.96 ^{A}±0.40	47.40^{C}±0.99	7.73^{A}±0.51	391.81^{D}±0.71
BPP 12%	17.30^{C}±0.26	15.89^{A}±0.83	16.27^{BC}±0.49	3.34^{A}±0.73	47.20^{AC}±0.62	7.56^{A}±0.38	396.89^{E}±0.88
BPP 15%	11.50^{D}±0.77	16.37^{A}±0.43	17.80^{C}±0.43	3.79^{A}±0.73	45.67^{AC}±0.66	7.06^{A}±0.85	401.21^{F}±0.23

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same column are significantly different (p<0.05).

Minerals content of cake samples:

Minerals content of cake samples containing substituted flour with different levels (3, 6, 9, 12 and 15 %) of banana peels powder (BPP) are described in Table (8).

The obtained results in Table (8) showed that significant increase in the minerals content in cake samples, when addition of different concentrations of banana peels powder (BPP) substitution of wheat flour (3, 6, 9, 12 and 15 %), is due to the containment of banana peels powder (BPP) on high levels of some important minerals.

From the same table showed that increase potassium, phosphorus and sodium in cake samples with banana peels powder (BPP) added, which gradually high significant (P<0.05) increases with increase the addition of banana peels powder (BPP) at (3, 6, 9, 12 and 15 %) recorded (257.87, 278.93, 288.27, 295.30 and 317.10 mg/100g), (200.37, 239.43, 270.00, 283.07, 294.40 mg/100g) and (387.31, 400.23, 419.83, 435.64, 481.53 mg/100g) respectively, which have a high content from these minerals (Table 3).

In general, the addition of banana peels powder (BPP) to the cake formula led to an increase in its content of minerals important to consumer health, support the product and increase its nutritional value compared to the control sample, which a lower content of minerals than samples containing different percentages of banana peels powder **(**BPP), (3, 6, 9, 12 and 15 %).

Table 8. Minerals content of cake samples containing substituted flour with different levels of banana peels powder (BPP) (mg/100g).

Samples	Minerals content of cake sample (mg/100g)								
	Na	P	Ca	S	K	Zn	Cu	Mn	Fe
Control	385.33^{A}±0.29	181.20^{A}±0.26	185^{AB}±0.26	5.23^{A}±0.55	6.30^{A}±0.11	1.60^{A}±0.30	5.77^{A}±0.19	0.49^{A}±0.01	8.53^{A}±0.75
BPP 3%	387.31^{A}±0.35	200.37^{B}±0.03	184.33^{B}±0.04	5.27^{A}±0.06	257.87^{B}±0.03	1.95^{A}±0.15	5.33^{A}±0.32	0.36^{B}±0.07	9.47^{AB}±0.51
BPP 6%	400.23^{B}±0.16	239.43^{C}±0.35	186.37^{AB}±0.29	2.47^{B}±0.25	278.93^{C}±0.19	3.47^{AB}±0.25	4.73^{A}±0.11	0.49^{A}±0.03	10.10^{AB}±0.79
BPP 9%	419.83^{C}±0.31	270.00^{D}±0.72	187.87^{AC}±0.12	5.53^{A}±0.06	288.27^{D}±0.43	4.13^{B}±0.07	4.56^{A}±0.19	0.60^{C}±0.05	11.63^{BC}±0.56
BPP 12%	435.64^{D}±0.37	283.07^{E}±0.67	190.14^{C}±0.58	5.59^{A}±0.29	295.30^{E}±0.23	7.03^{C}±0.57	4.54^{A}±0.73	0.66^{CD}±0.06	12.17^{BC}±0.42
BPP 15%	481.53^{E}±0.68	294.40^{F}±0.64	194.53^{D}±0.79	5.65^{A}±0.51	317.10^{F}±0.82	9.78^{C}±0.93	4.50^{A}±0.10	0.74^{D}±0.03	13.28^{C}±0.10

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same column are significantly different (p<0.05).

9- Color values of cake samples:

All color information is represented in terms of Hunter L, a, and b values, which reflect lightness, redness, and yellowness, respectively. The color values for cakes made with substituted flour containing varying amounts of banana peels powder (BPP) are listed in Table (9). The color of the crust and crumb of the cakes differed according to the quantity and type of supplemented materials; the crust became darker (lower L) as the banana peels powder (BPP) content was increased in comparison to the control cake. While there were significant variations in the yellowness of the crusts between the banana peels powder (BPP) samples, the banana peels powder (BPP) samples had higher b values than the control cake sample. In terms of crumb color, however, as the amount of banana peels powder (BPP) increased the L and values decreased, while the b values increased, meaning that the crumb became thicker, more reddened, and more yellow in color.

The control cake had a lighter crumb than the checked cakes. It was well understood that during cake baking, the crumb would not hit a temperature above 100 °C, preventing the Millard or caramelization reactions from occurring. As a result, the crumb color of the tested cakes was determined by the color of the substituted materials used and their interactions. Larrauri *et al.* (1999) also confirmed that the addition of green tea powder changed the color of the crumb and decreased the L and b values.

Banana peels powder (BPP) significantly reduced the redness of the crumb color as compared to the control. Their findings are consistent with those of who suggested that when a powder other than flour is applied, browning is affected by the type and color of the added powder (Perrin *et al.,* 2007).

Table 9. Color values of cake containing substituted flour with different levels of banana peels powder (BPP).

Samples	Hunter-lab color values of Crust				
	L	A	B	Chroma	Total intensity
Control	40.48	5.11	4.77	48.87	41.08
BPP 3%	45.27	5.35	4.92	52.83	45.85
BPP 6%	41.30	4.83	5.03	48.63	41.88
BPP 9%	39.78	4.27	5.59	48.37	40.38
BPP 12%	36.31	3.76	5.94	48.24	36.97
BPP 15%	33.10	3.38	6.31	48.76	33.83

BPP: Banana peels powder

Physical characteristics of cake samples:

Cake is one of the fundamental food products, necessary in human nutrition. It is produced through baking dough made of flour, water, possibly also salt and other additives. Cake quality depends on the properties of the raw materials and on the technological parameters applied in the process of production. The quality assessment of cake makes use of determinations of its physical properties, among which the most frequently tested are the volume, weight, and specific weight (true density) of cakes. The effects of banana peels powder (BPP) substitution level on physical characteristics (Weight, volume and specific volume) of cake are presented in Table (10).

Table 10. Physical characteristics of cake samples containing substituted flour with different levels of banana peels powder (BPP).

Samples	Cake physical characteristics			
	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)	Density (g/cm^3)
Control	123^{A}±0.50	330^{A}±0.15	2.68^{A}±0.23	0.37^{A}±0.11
BPP 3%	127^{BC}±0.68	310^{B}±0.50	2.44^{A}±0.11	0.40^{A}±0.08
BPP 6%	125^{AB}±0.82	290^{C}±0.15	2.32^{A}±0.65	0.43^{A}±0.08
BPP 9%	122^{A}±0.70	260^{D}±0.73	2.13^{AB}±0.28	0.46^{AB}±0.13
BPP 12%	130^{C}±0.34	220^{E}±0.86	1.69^{B}±0.48	0.59^{B}±0.07
BPP 15%	124^{A}±0.24	210^{F}±0.76	1.69^{B}±0.46	0.59^{B}±0.03

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same column are significantly different (p<0.05).

As shown in the obtained results (Table 10), the specific volume of cake gradually decreased with increasing banana peels powder (BPP) substitution level, but this decrease was more pronounced in the case of cakes made with 12 and 15% banana peels powder (BPP) substitution level, respectively, while the specific volume was (2.44, 2.32, 2.13, 1.69, and 1.69 cm3/g). The same pattern was observed in tested cake samples for volume, which decreased gradually and significantly (P<0.05) as the percentage of banana peel powder (BPP) was increased from 3 to 15%, while it decreased from 310 to 210 cm^3 respectively, as compared to 330 cm^3 recoded by cakes made entirely of wheat flour. This finding corroborates that mentioned by (El-Badry *et al.* 2014).

On the other hand, when the replacement amount of banana peels powder (BPP) was increased from 3 to 15%, the weight (g) of the cake increased gradually and significantly (P<0.05), ranging from 122 to 130 (g), respectively, when compared to control samples (123g). The former result is consistent with that of Ksouri *et al.,* (2015), who discovered that composites contain less volumes than pure wheat. This can be attributed to lower levels of gluten network in the dough, which results in a decreased dough's ability to grow, as well as a weaker cell-wall structure. The density of the cake, which is known as the weight of a unit cake volume (g/cm^3), was increased by substituting ascending banana peels powder (BPP) (Table 10). Contrary to volume and basic volume values of cakes, there were variations in density between control and 3, 6, 9, 12, and 15% banana peels powder (BPP) substituted cakes (p<0.05).

11- DPPH scavenging % of cake samples:

Concerning the use of industrial synthetic phenolic compounds in food systems, such as butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT), and their detrimental impact on human health (Williams et al., 1990). As a result, natural compounds were commonly used as antimicrobials and antioxidants to combat food-borne microorganisms, slow the growth of rancidity, and extend the shelf life of a variety of foods (Friedman, 2007 and Beverlya *et al.,* 2008).

As shown in Table (11), the DPPH scavenging percent of cake samples containing different levels (3, 6, 9, 12 and 15%) of banana peels powder (BPP) extract has been demonstrated to have antioxidant efficacy, and based on the results of the antioxidant ability test, the inhibitory concentration at 50% (IC_{50}) value for the DPPH scavenging activity of cake samples can be summarized that high significant (P<0.05). It is preferable to emphasize that a lower inhibitory concentration at 50% (IC_{50}) value indicates greater inhibitory activity against free radicals. Banana extracts' potent antioxidant properties can be due to the presence of a variety of antioxidant components (Mrvcic *et al.,* 2012).

These findings are consistent with those previously published in Tables (5), which suggested a decrease in the inhibitory concentration at 50% (IC_{50}) value of banana peels powder (BPP), (2.297 g/mL), implying a preference for peels powder. The banana peels powder (BPP) is a strong source of nutritional antioxidants, as demonstrated when wheat flour was substituted for banana peels powder (BPP) in the cake samples formula under analysis. However, the antioxidant effect increased as the amount of banana peel powder added increased (BPP).

On the other hand, higher polyphenol levels in the fruit peel have been linked to the natural protection mechanism that plant tissues have against various abiotic stresses.

As shown in the obtained results (Table 12), the total antioxidant capacity (TAC) of cake samples containing different levels (3, 6, 9, 12 and 15%) of banana peels powder (BPP) gradually increased with increasing (BPP) substitution level, while the TAC were (23.90, 24.80, 34.70, 38.82 and 50.68 mg GAE/g) for cakes made with whole wheat flour. The variations in antioxidant potential between these cake samples may be attributed to the form and concentration of total phenol present, which may account for this parameter (Aquino *et al.,* 2016). In the same Table (12), the rate of increase in TAC was observed in cake samples containing substituted flour containing varying amounts (3, 6, 9, 12, and 15%) of banana peels powder (BPP) These findings corroborate those in Table (4), where an increase in the total phenols content of banana peels powder (BPP) (1210.20 mg/100g) appears to contribute to the high antioxidant ability.

Table 11. DPPH scavenging % of cake samples containing substituted flour with different levels of banana peels powder (BPP).

Sample conc.	DPPH scavenging %									
(mg/ml)	0	1	2	4	8	16	32	64	128	Conditions with IC_{50} (µg/mL)
Control	0	0.07	0.22	0.35	0.60	1.27	9.92	26.96	40.68	137.42^{A}±0.99
BPP3%	0	1.15	4.08	8.84	13.30	22.66	43.39	71.22	85.78	39.26^{B}±0.91
BPP6%	0	0.20	0.62	1.73	6.18	15.18	42.09	80.06	90.36	38.6^{B}±0.25
BPP9%	0	1.64	3.87	5.60	17.55	34.25	68.93	90.04	93.35	23.2^{C}±0.72
BPP12%	0	1.46	4.08	6.77	19.70	32.43	75.05	93.25	95.82	22.5^{C}±0.18
BPP15%	0	1.20	4.36	11.10	29.57	43.29	83.38	92.92	96.07	18.45^{D}±0.39

BPP: Banana peels powder IC_{50}: Inhibitory concentration at 50%, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same column are significantly different ($p<0.05$).

Table 12. Total Antioxidant Capacity (TAC) of cake samples containing substituted flour with different levels of banana peels powder (BPP).

	Cake samples with different levels of BPP						
	BHT	Control	BPP				
			3%	6%	9%	12%	15%
TAC (mg GAE/g)	73.05^{F} ±0.46	19.03^{A} ±0.68	23.90^{B} ±0.78	24.80^{B} ±0.36	34.70^{C} ±0.35	38.82^{D} ±0.82	50.68^{E} ±0.07

TAC: Total Antioxidant Capacity BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same column are significantly different ($p<0.05$).

12- Microbiological quality:

The microbiological statuses of the ten formulated cakes understudy were evaluated after each three days during storage (25±1°C) for 12 days. Obtained results are shown in Tables (13) and (14).

From Table (13), it could be observed that cake samples containing 12 and 15% banana peels powder (BPP) showed their free of aerobic bacteria until 3 days of storage, while the microbial growth of aerobic bacteria appeared at the lower substituted cakes with banana peels powder (BPP), (3, 6, and 9%) and control sample after 3-12 days of storage.

From Table (14), it could be observed that cake samples containing 9 to 15% banana peels powder (BPP) showed their free of mold and yeast until 6 days of storage, while the mold and yeast growth appeared at the lower substituted cakes with banana peels powder (BPP), (3 and 6%) and control sample after 6-12 days of storage. These results are agree with Emara *et al.* (2010) who evaluated for their banana peels powder (BPP) effectiveness inhibition on some groups of microorganisms growth, these finding may be related to the comparative high natural antioxidants content and antioxidants activity in (BPP).

Table 13. Total Aerobic Count Bacteria of (log cfu/g) of cake samples containing substituted flour with different levels of banana peels powder (BPP).

Storage period (days) 25±1°C	Total Aerobic Count Bacteria of (log cfu/g)					
	Control	BPP				
		3%	6%	9%	12%	15%
0	N D	N D	N D	N D	N D	N D
3	1.7^{A} ±0.07	1.5^{A} ±0.15	1.3^{A} ±0.20	1.2^{A} ±0.64	N D	N D
6	2.5^{A} ±0.46	2.0^{AB} ±0.20	1.8^{AB} ±0.69	1.5^{AB} ±0.32	1.2^{B} ±0.53	1.1^{B} ±0.18
9	3.8^{A} ±0.78	3.5^{AB} ±0.68	3.2^{AB} ±0.36	2.7^{ABC} ±0.35	2.5^{BC} ±0.82	2.0^{C} ±0.62
12	4.6^{A} ±0.88	4.3^{A} ±0.54	4.0^{AB} ±0.33	3.7^{AB} ±0.67	3.4^{AB} ±0.85	3.2^{B} ±0.53

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same row are significantly different ($p<0.05$).

Table 14. Mold and Yeast Count of (log cfu/g) of cake samples containing substituted flour with different levels of banana peels powder (BPP).

Storage Period (days) 25±1°C	Mold and Yeast Count of (log cfu/g)					
	Control	BPP				
		3%	6%	9%	12%	15%
0	N D	N D	N D	N D	N D	N D
3	N D	N D	N D	N D	N D	N D
6	2.4^{A} ±0.73	1.2^{B} ±0.41	1.0^{B} ±0.36	N D	N D	N D
9	3.6^{A} ±0.50	2.6^{AB} ±0.68	2.2^{B} ±0.82	2.7^{AB} ±0.70	2.2^{B} ±0.34	1.5^{B} ±0.24
12	4.9^{A} ±0.23	3.8^{AB} ±0.11	3.5^{ABC} ±0.65	3.3^{BC} ±0.28	2.9^{BC} ±0.48	2.5^{C} ±0.46

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different capital letters in the same row are significantly different ($p<0.05$).

13- Sensory evaluation of cake samples:

The organoleptic properties of cakes made partially from wheat flour and banana peel powder (BPP), as influenced by the ingredients used in manufacturing treatments. Additionally, they were strongly associated with the physicochemical consistency requirements for these products. Sensory assessment, in conjunction with estimation, has been widely used to determine the consistency of cake. As a result, the organoleptic consistency parameters (general appearance, flavor, and taste, crust color, crumb color, crumb texture, and overall acceptability) of cakes partially substituted with banana peels powder (BPP) at levels of 3, 6, 9, 12, and 15% were evaluated. The mean sensory scores assigned to cake samples are shown in Table (15). According to the data in Table 15, there was no substantial difference in overall acceptability between samples containing banana peels powder (BPP) levels of 3, 6, 9, 12, and 15%, and also defined as excellent properties when compared to the control sample.

Cakes with a partial replacement of wheat flour with banana peel powder (BPP) at a level of 3% were characterized as having a high level of consistency in all sensory characteristics assessed and as having an excellent rating for all tested organoleptic properties (General appearance, Flavor, Taste, Crust color, Crumb color, Crumb texture and overall acceptability). Additionally, cakes containing up to 6% banana peels powder (BPP) were graded as very good for all organoleptic properties tested (General appearance, Flavor, Taste, Crust color, Crumb color, Crumb texture and overall acceptability).

In general, sensory analysis revealed no statistically significant difference between the samples, and that using banana peels powder (BPP) at levels of 3, 6, 9, 12, and 15% as an optional ingredient in cakes would be an excellent way to reduce waste and introduce a nutritious food without the use of food additives.

Table 15. Sensory evaluation of cake samples produced as affected by different replacement levels of banana peels powder (BPP).

cake samples	Sensory Properties							Grade
	General appearance	Crust color	Crumb color	Crumb texture	Flavor	Taste	Over all acceptability	
Control	$18.25^{a}\pm0.94$	$8.58^{a}\pm0.51$	$8.50^{a}\pm0.70$	$18.26^{a}\pm1.04$	$18.00^{a}\pm0.63$	$18.26^{a}\pm1.13$	$89.85^{a}\pm2.23$	Excellent
BPP3%	$17.70^{ab}\pm1.28$	$7.70^{b}\pm1.46$	$7.12^{ab}\pm3.19$	$17.95^{ab}\pm0.83$	$17.70^{ab}\pm1.35$	$17.95^{ab}\pm1.17$	$86.12^{a}\pm2.23$	Excellent
BPP6%	$17.69^{ab}\pm0.87$	$7.61^{b}\pm1.30$	$6.80^{ab}\pm2.82$	$18.00^{ab}\pm0.82$	$17.80^{ab}\pm0.90$	$18.00^{a}\pm0.84$	$85.90^{a}\pm2.23$	Very Good
BPP9%	$17.62^{ab}\pm1.15$	$7.87^{b}\pm1.11$	$6.50^{ab}\pm2.85$	$17.87^{ab}\pm0.84$	$17.41^{ab}\pm0.82$	$17.87^{ab}\pm0.93$	$85.14^{a}\pm2.23$	Very Good
BPP12%	$17.66^{ab}\pm1.30$	$7.79^{b}\pm1.75$	$7.41^{ab}\pm1.50$	$17.54^{ab}\pm1.09$	$17.58^{ab}\pm1.08$	$17.54^{ab}\pm1.07$	$85.52^{a}\pm2.23$	Very Good
BPP15%	$16.91^{b}\pm1.16$	$6.87^{c}\pm1.59$	$6.87^{ab}\pm1.83$	$17.33^{b}\pm1.11$	$17.29^{ab}\pm1.32$	$17.33^{ab}\pm1.37$	$82.60^{a}\pm2.23$	Very Good

BPP: Banana peels powder, (M±S.D) = Mean ± Std. Deviation. Values with different small letters in the same column are significantly different ($p<0.05$).

CONCLUSION

This work succeeded in achieving its aim represented in raising the quality and nutritional value of one of the most important bakery products, it is cake, by using banana peels as one of the agricultural processing wastes that did not receive enough awareness, whereas addition of banana peels powder to flour at levels (3, 6, 9, 12 and 15%) worked on the increase important quality characteristics of cakes such as: the physical, chemical and microbial properties, where the addition resulted in increase cakes content of nutrients important to human health, such as protein, essential amino acids and mineral elements. moreover, the addition of banana peels powder served to supply the cakes with large quantities of natural antioxidants such as phenols, flavonoids and carotenoids that are beneficial to human health, which delay the rancidity of the fat inside the product and also act as an antimicrobial, which positively extends the shelf life of the product. in addition, the partial substitution of cheap banana peels in place of wheat flour not only demonstrated the ability to produce a low-cost cake, but also preserved the sensory characteristics significantly and the samples that contain it received high marks as the control sample. It is true that they do not exactly match it but at the same time, do not stray too far from it. Therefore, the use of banana peels powder in cake fortification is an effective, promising method and may open new horizons in the field of bakery products fortification.

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استخدام قشر الموز كمنتج ثانوى لزيادة القيمة الغذائية للكيك

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الهدف من هذه الدراسة هو القاء الضوء على الجودة الغذائية لمسحوق قشر الموز وذلك باستخدامه كمصدر رخيص واحلاله جزئياً محل دقيق القمح لانتاج الكيك. وأظهرت النتائج أن قشور الموز تمثل أكثر من 50.7٪ من الوزن الإجمالي لفاكهة الموز والتي تهمل كمخلفات تصنيعيه مع امكانية استخدامها كمصدر جيد للمغذيات الكبرى والصغرى وكمضادات للميكروبات والأكسدة في التصنيع الغذائي, بالإضافة إلى أنه يعد مصدرا جيدا للبروتين (15.10٪) وخصوصا الأحماض الأمينية التي لا غنى عنها وكذلك الاملاح المعدنيه (25.19٪)، كما انه يحتوي على كمية كبيرة من الفينولات (1210.20 مجم/100 جم) و الفلافونويدات (1783.32 مجم/100 جم) و الكاروتينات (846.58 مجم/100 جم). كما أظهرت نتائج استبدال مسحوق قشر الموز بمستويات مختلفة (3، 6، 9، 12 و15٪) ارتفاع بعض خصائص الجودة المهمة مثل الخصائص الفيزيائية والكيميائية والميكروبية وكذلك الخصائص الحسية للكيك وذلك على الرغم من انخفاض الحجم النوعي للكيك المستبدل جزئيا بمسحوق قشر الموز تدريجيًا مع الزياده في نسبة الاستبدال. بالإضافة إلى ذلك، أدى استبدال دقيق القمح بمسحوق قشر الموز إلى امداد الكيك بكميات كبيرة من مضادات الأكسدة الطبيعية خاصة في العينات التي تم استبدالها عند المستوى 12 و15٪ من مسحوق قشور الموز والتي لها تأثير مفيد على صحة الإنسان كما انها تعمل كمضاد للميكروبات لإطالة فترة الصلاحيه للكيك المنتج. ايضا, أظهرت صفات الجودة الحسية للكيك أن هناك تباينا معنويا طفيفا بين العينة القياسيه والعينات الأخرى المحتوية على مسحوق قشر الموز حتى نسبة (6٪) وذلك لجميع الخواص الحسية المختبرة حيث اظهرت خصائص حسيه ممتازة عند مقارنتها بالعينة القياسيه. لذلك، أوصت هذه الدراسه باستخدام مسحوق قشر الموز بنسبة تصل الى 15% لتعزيز وتدعيم ورفع الجوده الغذائيه للكيك لما لها من فوائد عديده لصحة الانسان.