Chemical, Microbiological and Sensory Studies on Green Banana Exposed to Oven and Freeze drying

by

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Abstract :

Eating fruits and vegetables protects against chronic diseases. Banana is a fruit rich in fiber and its use as an ingredient in various food products has a beneficial effect on human health. Therefore, the aim of this study is to use green bananas exposed to oven drying and freeze drying in order to raise the nutritional value of cake product. The chemical composition and antioxidants of green bananas exposed to oven drying and freezing were estimated. The results showed that green bananas were exposed to freeze drying better than green bananas exposed to oven drying in terms of chemical composition. The results showed that green bananas exposed to oven drying and freeze drying contain (24.02 and 29.08) of antioxidants respectively. Chemical composition and sensory tests were estimated, and microbiological analyzes were performed for cake samples prepared by replacing (10% and 20%) of wheat flour with banana pulp. It was found that cake samples prepared by replacing (10% and 20%) of wheat flour with green banana pulp subjected to freeze drying were better than cake samples prepared with replacement (10% and 20%) of green wheat flour subjected to oven drying. in terms of

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chemical composition When conducting sensory tests for cake samples prepared by replacing (10% and 20%) of wheat flour with green banana pulp subjected to freeze drying, there was general acceptance of the cake, but the best acceptance was for cake samples prepared by replacing (10% and 20%) of wheat flour with green banana pulp Exhibit freeze drying. When conducting microbiological analyzes for cake samples that were subjected to green banana pulp for oven drying and freeze drying, a decrease was observed in the total number of bacteria, spore-forming bacteria, fungi and yeast in the prepared cake samples by replacing (20)%) wheat flour with green banana pulp for freezing drying. This is due to the presence of antioxidants in green bananas exposed to oven drying and freeze drying.

Keywords: Green banana, Cake, Chemical analysis, Antioxidants, Microbiological Analysis.

1. Introduction

Fruits are sweet or sour fleshy structures of a plant that are edible in the raw state. These are rich sources of vitamins and sugars, along with bioactive compounds (including fiber and phenolic compounds) and have been associated with reducing the risk of major chronic degenerative diseases. (Singh et al., 2015). Banana is a very popular fruit in the world market ranking next to rice, wheat and maize in terms of its importance as a food crop (Lassoudière, 2007). The word ‘banana’ refers to the fruit of evergreen monocotyledonous, perennial, giant herb, exclusively subtropical belonging to the genus *Musa* from the family *Musaceae*. Balwinder et al., (2016) stated that it has been classified into the dessert or sweet bananas and the cooking bananas or plantains. It is either eaten

raw or processed, and also as a functional ingredient in various food products. Banana is very rich in carbohydrates, vitamins C (also A and some B vitamins) and several important minerals, including potassium, copper, magnesium, calcium and iron (Blessing et al., 2015). Banana contains several bioactive compounds, such as phenolics, carotenoids, biogenic amines and phytosterols, which are highly desirable in the diet as they exert many positive effects on human health and well-being. Many of these compounds have antioxidant activities and are effective in protecting the body against various oxidative stresses (Balwinder et al., 2016). In the past, bananas were effectively used in the treatment of various diseases, including reducing the risk of many chronic degenerative disorders. Besides having good taste, banana has multiple health benefits. It can fight against intestinal disorder, and has antibacterial and antioxidant activities (Jain et al., 2011). The generally accepted health benefit is the immunostimulatory activity. Banana has been reported to have abundant phytochemicals. Bananas consist of two parts, the banana pulp (BP) and the banana peel (BPe). The pulp is a rich source of essential phytonutrients, phenolic compounds, B group vitamins, ascorbic acid and tocopherols, while the (BPe) is a rich source of minerals, bioactive compounds and dietary fiber (DF) such as pectin, cellulose, hemicelluloses and lignin (X. Zhu et al., 2018). The consumption of green banana (GB) products is booming because of their nutritional and physiological benefits to human health (Zandonadi et al., 2012). GB is a good source of fibers, vitamins, minerals, and bioactive compounds (such as phenolic compounds), and resistant starch (Lii et al., 1982; Chávez-Salazar et al., 2017).

Processors are inclined towards using banana in the health food industries, confectionaries and bakeries due to its richer content of polyphenolic compounds like carotenoids, dopamine, serotonin, norepinephrine, gallocatechin, epicatechin, catechin and minerals like potassium and magnesium (Alkarkhi et al., 2011; Menezes et al., 2011, and Suresh et al., 2018). The bakery products such as cakes are widely consumed all over the world; hence, their enrichment with vitamins, minerals, polyphenols and fibers is considered as an effective way to produce high nutritional value foods, achieving this goal is possible using fruits and vegetables in the formulation of food products (Fakhreddin and Sara, 2019). The cake is one of the most common and popular bakery foods and generally prepared by using wheat flour, sugar, egg, baking powder, flavorings etc. Literally lots of cakes recipes are available and these cakes can be classified based on ingredients, cooking techniques and accompaniment such as coffee cakes, occasion cakes (Eke et al., 2008). After slicing the fruits and vegetables, drying treatments are used to reduce the water activity of the fresh ones and also manufacturing new food products such as powder of fruits and vegetable. Powder of the dried fruits and vegetables is known as a good source of nutrients for bakery products. Different mechanical and chemical methods are used in food industries to reduce the moisture content of the waste of the fruits and vegetables and turning them into powders (Salehi et al., (2016). Dehydration allows for long term storage of fruits thus allowing preservation of vitamins and other nutrients of fresh fruits and vegetables that are critical for human health (Cadenas and Packer., 2002). Compared to other methods of drying, freeze-drying is considered to be the best

dehydration method for heat-sensitive materials to enable achievement of the highest possible quality, minimal comprising of color, structure, nutrients and flavor. However, due to its fast ripening rate after harvest and high perishability, harvested bananas must be consumed shortly after harvest or subjected to further processing to avoid spoilage (Maskan, 2000; Nimmol et al., 2007). Demand of processed foods is increasing significantly throughout the world. Bakery products are also getting notable preference in the global food sector (Kotsianis et al., 2002). Bakery products such as cakes are widely consumed all over the world; hence, their enrichment with vitamins, minerals, polyphenols and fibers is considered as an effective way to produce high nutritional value foods. Achieving this goal is possible using fruits and vegetables in the formulation of food products (Fakhreddin and Sara, 2019). Interest in nutrition has been driving consumer demand to lower unhealthy fats and sugar levels, as well as calorie consumption. Therefore, it is necessary to improve the nutritional composition. The aim of this study is to use green banana exposed to oven drying and freeze drying as natural antioxidants to raise the nutritional value of a cake.

2. Material and Methods

2.1. Material

Green banana were purchased from the local markets of Benha city, Egypt. The ingredients used in making the cake were purchased from the local markets of Benha city, Egypt. Chemicals were obtained from Alpha chemicals company, Egypt.

2.2. Methods

2.2.1. Prepare green bananas pulp:

Bananas were peeled, cut into rings, and then, dried in two ways:

a- In the oven at 40 ° C until dried

b- Using freeze drying in freeze dryer

Then the dried banana pulp was ground well to obtain a fine powder until use.

2.2.2. Cake preparation:

The standard cake was prepared according to the method described by (le Cordon Bleu, 2010).

2.2.3. Preparing the cake replacement with green banana pulp

Part of the flour for the standard cake was replaced with green banana pulp powder at 10% and 20%.

Then the cake cooked in an oven at 180 ◦c for a 20 minute.

2.2.4. Chemical analysis

Moisture, protein, Ash, Total Lipids and Crude fibers content of dried green banana pulp and all cake samples were determined according to the method described by AOAC, (2005). Carbohydrates of dried green banana pulp and all cake samples were calculated by the difference as the following equation:

% Total Carbohydrates = 100 - % [Protein + Fat + Ash + Fibers].

Results calculated as g/100g on dry weight basis).

2.2.5. Determination of anti-oxidant activity

Anti-oxidant activity_were determined in green bananas pulp according to the method described by Lee, et al., (2003)

2.2.6. Determination of total bacterial count:

Serial dilution of samples was prepared from 10^{-1} to 10^{-3}. On ml from dilution of cake samples were plated using

sterilized basal medium (by auto-claving at 121 ◦C for 20 minutes) according to ICMSF, (1978).

The medium composed of:

Peptone	5.0 g /1
Yeast extract	5.0 g /1
Dextrose	5.0 g /1
Beef extract	3.0 g /1
Agar	15.0 g /1

2.2.7. Determination of total Psychrophilic bacteria count

The same previous procedures and medium were used, but the incubation was done at 4 ±1◦Cfor a week in refrigerator.

2.2.8. Determination of spore forming bacteria:

Spore forming bacteria count was numerated on plate count agar media after heating at 80◦C for 15 minute.

Incubation was performed at 32◦C for 24 hours according to (ICMSF, 1978).

2.2.9. Fungi and yeast count

Sabouraud Dextrose Agar medium of ICMSF, (1978)

Was used for molds and yeasts count. The medium consisted of:

Peptone	10.0 g/ 1
Agar	15.0 g/ 1
PH	5.0 ± 0.2
Dextrose	40.0 g / 1

The medium was sterilized by autoclaving at 121◦C for 15minutes.

Plates were incubated at room temperature 30◦C for five days.

2.2.10. Organoleptic tests

Organoleptic evaluation i.e color, odor, texture, taste and over all acceptability of cake samples were evaluated by the

panelists of the stuff members of Department of Home Economics, Faculty of Specific Education, Benha University. According to the method described by Watts et al., (1989).

2.2.11. Statistical analysis

The data were expressed as means ± standard deviations (SD) of three replicates. Statistical calculations were carried out by SPSS version 10.0 software SPSS, (1998). One way of variance analysis was applied for determining differences between results of samples. Duncan test was taken to compare the data. Values of ($P \leq 0.05$) were considered as significant different.

3. RESULTS AND DISCUSSION

Chemical composition of green banana pulp samples (oven drying and freeze drying).

Table 1 showed the chemical composition of green banana pulp samples (oven drying and freeze drying).The obtained results showed that moisture, protein, fat, carbohydrate, ash and fiber content for oven drying green banana pulp were 8.10, 0.95, 1.90, 75.9, 3.95and 9.25% respectively. Where freeze drying green banana pulp were7.30, 0.97, 1.85, 74.34, 3.75 and 11.75% respectively. There were significant differences ($P \leq 0.05$) between oven drying and freezing drying for yellow and green banana pulp. These results are in agreement with Bithika Saha et al. , (2018) reported that the average moisture content of fresh bananas was 74% wet base and final moisture varied from 8 to 13% depending on the drying condition.

Table 1 Chemical composition of green banana pulp samples (oven and freeze drying)

Chemical composition (%)	Green banana pulp samples		
	Oven drying	Freeze drying	LSD $*_{0.05}$
Moisture	8.10 ± 0.36^{a}	7.30 ± 0.17^{b}	0.7
Protein	0.95 ± 0.10^{b}	0.97 ± 0.12^{a}	0.02
Fats	1.90 ± 0.08^{a}	1.85 ± 0.08^{b}	0.03
Carbohydrate	75.9 ± 1.65^{a}	$74.34\pm1.79_{b}$	1.1
Ash	3.95 ± 0.43^{a}	3.75 ± 0.64^{b}	0.2
Fibers	9.25 ± 1.14^{b}	$11.75\pm1.12_{a}$	0.9

Value ± SD with the same latter in the same column are not significantly different ($P\leq0.05$)

*: Least significant differences.

Antioxidant activity by DPPH (%) in yellow and green banana pulp (oven drying and freeze drying)

Percentage of antioxidant activity by DPPH radical scavenging activity (%) in green banana pulp exposed to oven drying and freeze drying (Table 2). It is clear from the results that the green banana pulp exposed to drying in the oven and freezing contained a percentage of antioxidants that amounted to 24.02% and 29.08, respectively. These results are in consistent with those reported by Singh et al., (2016) who reported that banana is considered as one of the most important antioxidant rich foods. A substance functions as an antioxidant if it can delay, retard or prevent the oxidation or free radical mediated oxidation of a substrate when present in low concentrations, leading to the formation of stable radicals after scavenging.

Banana fruit contains bioactive compounds having antioxidant potentials, which contributes to their physiological defense against oxidative and free-radical-mediated reactions in the biological systems. Sulaiman, Yusoff, et al. (2011) studied that the correlation between total phenolic as well as mineral contents with the antioxidant activities of pulps and peels from eight banana cultivars and suggested that antioxidant activity of banana is not only due to their phenolic content, but also due to many other compounds, such as vitamin C, vitamin E and b-carotene, which were accountable in enhancing the antioxidant potential.

Table 2 Antioxidant activity by DPPH (%) in yellow and green banana pulp exposed to oven drying and freeze drying.

Material	Antioxidant Activity DPPH (%)
Green dried banana pulp (oven drying)	24.02
Green dried banana pulp (freeze drying)	29.08

Chemical composition of cake with green banana pulp (oven drying and freeze drying)

Chemical composition (%)	Treatments					LSD*0.05
	Control cake	Cake supplemented with green banana pulp 10%		Cake supplemented with green banana pulp 20%		
		Oven drying	Freeze drying	Oven drying	Freeze drying	
Moisture	27.42 ±1.21[d]	27.8±0.35[c]	27.75±0.40[d]	28.5±0.55[b]	28.9±0.51[a]	0.2
Protein	8.48± 0.10[a]	8.12±0.06[a]	8.15±0.11[a]	7.76±0.07[b]	7.80±0.18[b]	0.15
Fats	33.80 ±0.89[a]	33.71± 0.75[b]	33.73±0.61[b]	33.62± 0.46[d]	33.65± 0.85[c]	0.03
Carbohydrate	26.48 ±1.19[a]	26.3±1.22[a]	26.24±1.24[b]	25.55± 1.14[c]	25.01± 1.30[c]	0.08
Ash	1.65± 0.02[b]	2.20±0.08[a]	1.43±0.06[c]	1.15±0.35[d]	1.19±0.06[d]	0.04
Fibers	2.16± 0.02[d]	2.67±0.04[d]	2.70±0.08[c]	3.42±0.05[b]	3.45±0.13[a]	0.02

Table 4 shows the chemical composition of cake samples with green banana pulp (oven drying and freeze drying). The obtained results showed that the percentage of moisture, protein, fat, carbohydrates, ash and fiber in the control cake was 27.42, 8.48, 33.80, 26.48, 1.65 and2.16% respectively. While cake samples replaced 10% wheat flour with green banana pulp subjected to oven drying 27.8, 8.12, 33.71, 26.3, 2.20 and 2.67% respectively. Where the samples of cake replaced 10% wheat flour with green banana pulp subjected to freeze drying were 27.75, 8.15, 33.73, 26.24, 1.43 and 2.70 %

respectively. Where the cake samples replaced 20% wheat flour with green banana pulp subjected to oven drying were 28.5, 7.76, 33.62, 25.55, 1.15 and 3.42 % respectively. While samples of cake replaced 20% of wheat flour with green banana pulp subjected to freeze drying was 28.9, 7.80, 33.65, 25.01, 1.19 and 3.45% respectively. There were significant differences (P≤0.05) between cake sample (control sample) and cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp exposed to oven drying and freeze drying. The difference in some chemical analysis results for cake prepared by replacing (10 and20%) of wheat flour with green banana pulp exposed to oven drying and freeze drying due to the difference in chemical composition of bananas from wheat flour.

Table 4 Chemical composition of cake supplemented with green banana pulp (oven drying and freeze drying).

Value ± SD with the same latter in the same column are not significantly different (P≤0.05) *: Least significant differences

Sensory properties of cake with green banana pulp (oven drying and freeze drying). (Zero Time, Three days and Six days)

Table 5 shows the organoleptic characteristics of the cake prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to oven drying and freeze drying. It should be noted that the control sample obtained the highest score in terms of appearance, color, texture, taste and smell. But cake samples prepared with replacement (10 and 20%) of wheat flour with green banana pulp subjected to freeze drying were better in sensory evaluation compared to cake samples prepared with replacement (10 and 20%) of cake. Wheat flour

with green banana pulp subjected to oven drying. From the same table (5) the sensory characteristics of the cake prepared by replacing (10 and 20%) of wheat flour with green banana pulp subjected to oven drying and freeze drying during three days. It should be noted that the control sample obtained the highest degree in sensory evaluation. But cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to oven drying and freeze drying were less acceptable in sensory evaluation compared to the sample. However, cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to freeze drying were better in sensory evaluation compared to cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to oven drying. The same table presents the sensory characteristics of the cake prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to drying and freeze drying in the oven during six days. We find that the control sample got fewer acceptances in terms of appearance, color, texture, taste and smell compared to the control sample during zero time and three days. Also, we find that cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp subjected to oven drying and freeze drying got less acceptance compared to cake samples prepared by replacing (10 and 20%) wheat flour with green banana pulp exposed to oven drying and freeze drying during zero time and three. days. Cake prepared by replacing (10 and 20%) of wheat flour with green banana pulp subjected to freeze drying had better results than cake prepared by replacing (10 and 20%) of wheat flour with green banana pulp subjected

to oven drying, because freeze drying preserves the active substances and antioxidants more than oven drying

Table 6 Sensory evaluation of cake supplemented with green banana pulp (oven drying and freeze drying).

Storage Period	Sensory evaluation	Treatments					LSD*$_{0.05}$
		Control cake	Cake supplemented with green banana pulp 10%		Cake supplemented with green banana pulp 20%		
			Oven drying	Freeze drying	Oven drying	Freeze drying	
Zero time	Appearance	9.2±0.42^{a}	8.55±0.64^{b}	8.75±0.42^{b}	8.45±0.47^{b}	8.50±0.41^{b}	0.2
	Color	9.0±0.48^{a}	8.25±0.67^{b}	8.65±0.67^{b}	8.2±0.42^{b}	8.3±0.63^{b}	0.35
	Texture	8.8±0.48^{a}	8.35±0.67^{b}	8.55±0.50^{b}	8.25±0.79^{b}	8.33±0.50^{b}	0.22
	Taste	8.9±0.57^{a}	8.3±0.79^{c}	8.4±0.84^{b}	8.22±0.67^{d}	8.35±0.42^{d}	0.03
	Odor	8.9±0.57^{a}	8.17±0.78^{b}	8.3±0.67^{b}	8.0±0.67^{c}	8.15±0.75^{c}	0.1
Three days	Appearance	8.2±0.26^{a}	7.6±0.52^{d}	8.0±0.41^{b}	7.8±0.48^{c}	7.6±0.66^{d}	0. 2
	Color	8.1±0.52^{a}	7.8±0.48^{a}	7.6±0.63^{b}	7.5±0.53^{b}	7.3±0.42^{b}	0.3
	Texture	7.7±0.42^{a}	7.55±0.44^{b}	7.53±0.44^{b}	7.4±0.46^{c}	7.45±0.46^{c}	0.07
	Taste	7.9±0.21^{a}	7.25±0.54	7.6±0.52^{a}	7.35±0.53^{a}	7.35±0.47^{a}	0.22
	Odor	7.8±0.35^{a}	7.05±0.28^{d}	6.95±0.55^{d}	7.2±0.26^{c}	7.3±0.35^{b}	0.04
Six days	Appearance	7.25±0.49^{a}	6.6±0.66^{d}	6.85±0.58^{c}	6.95±0.60^{d}	7.1±0.57^{b}	0.03
	Color	6.95±0.	6.45±0.	6.5±0.6	6.4±0.4	6.5±0.7	0.05

		64[a]	50[c]	2[b]	6[c]	5[b]	
	Texture	6.6±0.46[a]	6.4±0.46[b]	6.15±0.71[c]	6.4±0.6[b]	6.25±0.49[c]	0.05
	Taste	6.6±0.52[a]	6.05±0.28[d]	6.1±0.21[d]	6.2±0.26[c]	6.25±0.26[b]	0.02
	Odor	6.5±0.47[a]	6.2±0.35[d]	6.15±0.34[d]	6.45±0.16[b]	6.3±0.26[c]	0.03

Value ± SD with the same latter in the same column are not significantly different (P≤0.05)

*: Least significant differences.

Microbiological analysis of cake with green banana pulp (oven drying and freeze drying). (Zero time, three days and six days)

Table (13) shows the microbiological analysis of cake samples replaced (10 and 20%) of wheat flour with green banana pulp subjected to oven drying and freeze drying. (Zero time, three days and six days).there were decrease in the total number of bacteria, spore-forming bacteria, Fungi and yeast count in cake samples replaced (10 and 20%) of wheat flour with green banana pulp subjected to oven drying and freeze drying. (zero Time, three days and six days) compared to the control sample, and the best results were cake samples prepared with the replacement (20%) of wheat flour with green

Banana pulp subjected to freeze drying. Whereas, as the storage period progresses, an increase in the total number of these measurements were notice. These results are attributed to the high level of antioxidants in cake samples prepared with the replacement (10 and 20%) of wheat flour with green banana pulp subjected to oven drying, which acts as antimicrobial. Sulaiman, Youssef et al. (2011) studied the relationship between total and mineral phenolic content with the antioxidant activities of the pulp and peel of eight banana varieties and

suggested that the antioxidant activity of bananas is not only due to their phenolic content, but also due to many other compounds, such as vitamin C, vitamin E and B carotene, which was responsible for enhancing the antioxidant potential. Rabbani, et al., (1999) it is reported that green banana produces antidiarrheal activity in children.

Table 8 Microbiological Analysis of cake supplemented with green banana pulp (oven & freeze drying) during storage period.

Microbiological Analysis	Storage Period	Treatments				
		Control cake	Cake supplemented with green banana pulp 10%		Cake supplemented with green banana pulp 20%	
			Oven drying	Freeze drying	Oven drying	Freeze drying
Total bacterial count	Zero time	1.8×10^3	1.6×10^3	1.45×10^3	1.3×10^3	1.2×10^3
	3 days	2.6×10^3	2.4×10^3	2.1×10^3	1.9×10^3	1.5×10^3
	6 days	3.4×10^3	3.2×10^3	2.7×10^3	2.2×10^3	2.0×10^3
Spore forming bacteria	Zero time	2.8×10^2	2.6×10^2	2.4×10^2	2.2×10^2	1.9×10^2
	3 days	3.7×10^2	3.2×10^2	2.9×10^2	2.5×10^2	2.3×10^2
	6 days	4.6×10^2	4.2×10^2	3.8×10^2	3.5×10^2	2.9×10^2
M.Y	Zero time	8.3×10^2	7.9×10^2	7.4×10^2	6.2×10^2	6.0×10^2
	3 days	9.6×10^2	8.9×10^2	7.9×10^2	6.8×10^2	6.5×10^2
	6 days	10.2×10^2	9.2×10^2	8.2×10^2	7.7×10^2	7.2×10^2

S.Y	Zero time	18×10^2	16.5×10^2	15.8×10^2	14.4×10^2	13.3×10^2
	3 days	23×10^2	19.4×10^2	18.2×10^2	17.2×10^2	16.8×10^2
	6 days	26×10^2	23.3×10^2	22.3×10^2	20.2×10^2	19.8×10^2

4. Conclusion

Powdered green banana is desirable and has nutritional values for cake production. It contains antioxidants compounds that improve their natural antioxidants. In this study green banana dried by oven and freeze drying and added to white flour during cake processing with 10 % and 20 % to improve their mutational quality. The data summarized that the freeze drying was the best treatment for green banana and their cake samples were the lowest microbiological evaluation and highest sensory properties due to antioxidants and antimicrobial of green banana.

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