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Utilization of Banana or Pomegranate Wastes for Improving Nutritional and Organoleptic Properties of Cookies

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Abstract

Dried peel powder of banana or pomegranate were used to supplement cookies at 5 to 20%. Chemical analysis of the powder revealed higher content of banana peel powder (BPP) with protein, fat and ash beside the minerals (K, Ca, Fe and Zn) than pomegranate peel powder (PPP) which had higher content of carbohydrate, total phenols and antioxidant activity. Identification of phenols by HPLC revealed that PPP was rich in Gallic and Ellagic acids and the flavonoid Cateachin with values 3843.96, 2494.63 and 149.38 µg/g respectively. Also, PPP had higher content of all phenolic acids, except Cinnamic acid and the flavonoid Rutin which were higher in BPP. The phenols P-coumaric, Rosmarinic, Qurecetin and Chrysin were only found in BPP. Meanwhile; Feruelic and Ellagic acids were only detected in PPP. Cookies supplemented with 20% BPP or PPP contained significantly high quantities of ash, fiber and minerals. Also, cookies incorporated with PPP had higher total phenolic content and antioxidant activity than that supplemented with BPP at the same level. However, sensory evaluation of the cookies revealed that BPP or PPP could utilized for improving the sensory scores at low concentration 5 or 10%.

Keywords: Peel powder; banana; pomegranate; cookies; total phenol; antioxidant; chemical analysis; HPLC; sensory evaluation

1. Introduction

The last ten years have seen a fast progress for added foodstuffs with the association between foods with functional properties besides the nutritional [1]. Cookies is a bakery product made by mixing sugar, salt, oil, food items, and one or more other substances authorized by laws into flour and shaping, baking, and adding baking powder. Because of its convenience, nutritional goodness, and low cost, the cookie is a popular bakery product. Cookies are a popular snack because they may last for a long time without rotting, they appeal to the consumer's taste, they can be offered in a variety of flavours and they can be consumed as a snack when the three normal meals do not supply enough nutrients [2]. Although wheat flour, which is used to make cookies, is a healthy source of carbohydrates, it may be deficient in fibre, minerals and biomolecules such as antioxidants, which are needed to meet the nutritional needs of consumers [3].

Fruits by-products represent huge quantity, approximately 40 and 50% of banana and pomegranate fruit respectively, that must be exploited well as it causes harm to the environment and the human health [4].

The large amount of fruits by-product made it as possible for using in preparing functional foods [5]. Fruit wastes considered as good resource of minerals, vitamins and other bioactive compounds and are good source of fiber as well [3].

Potassium is the major element found in banana peel (9.39% DW) followed by Mg, Ca, Na, P and micro elements Fe, Mn, Zn and Cu [6]. Also, adding BPP to chapatti revealed higher total phenolic and flavonoid content than the control and the best proportion of addition was 15% BPP [7]. Banana peel is a rich source of flavonoids and phenolic component proanthocyanidin and oligomers, polymers, Ferulic acid and P-coumaric [8]. Pan bread fortified with banana peel flour had a high level of fiber and ash [9].

Biscuits fortified with banana peel flour (BPF) had a higher ash amount than the control, indicating an increased mineral content due to the addition of BPF. When examining the composition and sensory evaluation of the prepared biscuits, it was observed

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that high quality BPF-enriched biscuits could be made by substituting WF up to 10% [10].

Pomegranate peel extracts have antioxidant and anti-mutagenic properties led to a decrease in tumor necrosis factor (TNF-α) and has a potential source of natural antimicrobial agents and antioxidants, as well as tyrosinase inhibitors, that can be used as biological preservative in food application [11], [12], [13].

PPP is a rich source of total poly phenols such as, ellagic acid, Gallic acid, catechins, caffeic acid, p-coumaric acid and resorcinol compounds. These poly phenols are responsible for the antioxidant properties of PP in addition to total antioxidant activity values. This indicates the potential use of PPP in food industry to enhance the quality of and increase the shelf life of products food materials. Also, the predominant minerals in pomegranate peel powder (PPP) were Mg, Ca, K, Mn, Zn and Fe [14], [15].

Adding PPP to cookies had a significant effect on color and the product remained in acceptable shape [3]. Also, muffin cakes supplemented with PP by 5 or 10 % led to a significant increase in soluble total dietary fiber, phenolic content and antioxidant as well as mineral elements as Mg, Ca and K [15]. In general, Pomegranate peel flour PPF can be used in other foods, especially in sweet baked goods as well as sweeter products such as jams and juices and consequently the utilization of PPF will help to decrease environmental pollution [16].

There for the objective of this study was to investigate the utilization of banana and pomegranate peels as a waste for improving the nutritional values and antioxidant activities of cookies. Besides, the level of BPP or PPP in cookies that produces acceptable sensory evaluation for consumer was determined.

2. Materials And Methods

2.1Materials

Pomegranate fruit Manfalouty (Punica granatum L.) and banana fruit (Musa acuminate, cv. Grande Naine) were purchased from Egyptian local market. Wheat flour (72% extraction), hydrogenated vegetable ghee, sugar, eggs and baking powder were bought from the local market, Giza, Egypt. All chemicals and reagents used in this study were of analytical grade and were obtained from Sigma-Aldrich co. (St. Louis, MO, USA).

2.2 Methods

2.2.1 Preparation of banana and pomegranate peels powder

The pomegranate and banana fruits were washed with tap water and peel were removed by a knife manually. The pomegranate peels were cut into small pieces and dried in the oven (DRTH, Dreieich, West Germany) at 50°C for 48 h. Banana peels only were cut into small pieces and were put in 0.5 % (w/v) citric acid for 10 minute, then they were dried in the same oven at 55°C for half an hour and the drying was completed for 48 hours at 50°C. The dried pomegranate and banana peels were ground in a mill to a fine powder (Braun 4184-625 Blender, Czech Republic) to pass through 1mm sieved and stored in glass jar at -18°C until analysis.

2.2.2 Formulas of cookies with different levels of pomegranate and banana peel powder

Cookies were prepared according to [3] the formulas are shown in Table (1). After manufacturing cookies, baking was done at 170 – 180ºC for 15-20 min. Cookies were leaved to cool at room temperature (27± 3°C) for 8–10 min and kept in airtight glass jars for additional analysis.

2.3 Analytical Methods

2.3.1 Chemical analysis

Moisture, protein (N x 5.71), lipids (ether extract), ash and crude fiber contents of samples were determined according to [17]. Moisture was estimated in hot air oven at 105 ^{0}C up to constant weight. Peel powder samples were ashed in muffle furnace at 550 ^{0}C for 5–6 h until constant weight. Crude protein was determined by Kjeldhal method and crude fiber contents were measured by acid and alkali digestion and the lipid content was determined by Soxhlet method. Carbohydrates were calculated by difference.

2.3.2 Mineral analyses

Mineral analyses were performed on Agilent 5100 Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES) with Synchronous Vertical Dual View (SVDV) according to [18] for each series of measurements intensity calibration curve was constructed composed of a blank and three or more standards from Merck Company (Germany). Accuracy and precision of the metals measurements were confirmed using external reference standards from Merck (central lab, national research center, Egypt).

2.3.3 Total phenolic content of banana and pomegranate peel extracts and cookies

Dried banana, pomegranate peels and their Supplemented Cookies were converted into fine powder using a pestle and mortar. About 10g powder of samples was extracted with 100ml of 80% ethanol separately, homogenized well overnight at room temperature using shaker (sample: solvent ratio, w:v, 1:7). The mixture was filtered through whatman No 1 filter paper and the extraction step was repeated triplicate. The filtrate was concentrated at 40^{o}C under vacuum in rotary evaporator. Obtained liquid was stored at -18^{o}C until analysis.

Total phenolic content was determined according to the Folin-Ciocalteu procedure of [19]. The total phenolic content was determined by means of a calibration curve prepared with Gallic acid, and expressed as mg of Gallic acid equivalent (mg GAE) per g of dry weight sample.

2.3.4 Antioxidant activity of banana and pomegranate peels extracts and cookies.

The antioxidant activities of samples were determined using the free radical, 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as a reagent according to the method described by [20]. Percent inhibition of the DPPH free radical was calculated by the following equation:

Inhibition (%) = 100 × [(Acontrol-Asample)/Acontrol]

Where:

Acontrol is the absorbance of the control reaction (containing all reagents except the test compound). Asample is the absorbance with the test compound. The standard curve was prepared using Trolox. Results were expressed as mg Trolox equivalents TE /g of dry weight samples.

2.3.5 Identification of phenolic compounds of banana and pomegranate peels powder extract

Phenolic compounds were fractionated using HPLC (Agilent Technologies 1100 series) according to the method of [21]. Phenolic compounds of samples were identified by comparing their relative retention times with those of the standard mixture chromatogram. The concentration of an individual compound was calculated on the basis of peak area measurements and then converted to µg phenolic / g dry weight [6].

2.3.6 Sensory evaluation

Sensory characteristics of the cookies samples were evaluated using 10 trained panelists from Food Science Dep., Fac. Agric., Cairo University, according to the method of 9-point Hedonic Scale [22]. Cookies samples were given codes and served to each panelist in a randomized order. The panelist's mouth was rinsed with water to remove any traces of residual food. Each panelist was asked to rate the quality attributes of the cookies sample (taste, color, odor, texture and overall acceptability). The panelists were in advance with the aim of the study and were given questionnaires to write their observations. The information contained on the proforma was; 9= like extremely; 8=like very much; 7=like moderately; 6=like slightly; 5=neither like nor dislike; 4=dislike slightly; 3=dislike moderately; 2=dislike very much; 1=dislike extremely.

2.4 Statistical analysis

Three replicates were done for each analysis and the values were expressed as mean±SD. The collected data gotten from the quality parameters of the pomegranate and banana peel supplement cookies were statistically analyzed through analysis of variance technique using SPSS version 22.0 statistical processor software and least significant difference (LSD) was used to determine the level of significance among means at $P < 0.05$.

3. Results and discussion

3.1 Chemical composition of BPP or PPP and cookies supplemented with them:

The chemical composition of dried peel Grande Naine of banana fruit and Manfalouty pomegranate and cookies supplemented with them are presented in (Table 2 and 3). The results showed that the chemical composition of banana peel powder (BPP) and its supplemented cookies had higher amounts of protein, fat, ash and fiber when compare with pomegranate peel powder (PPP) and its cookies (Table 3). The proximate composition of control cookies and cookies containing BPP or PPP at levels 5 to 20 % are described in (Table 2 and 3). The cookies supplemented with 20% BPP or PPP contained significantly higher quantities of ash and fiber content (3.98, 3.18) and (1.77, 4.27) respectively when compared with control and other cookies. The crude protein and fat content for control cookies Tables (2

and 3) were 8.83%, 25.84% respectively. Reducing in protein content of supplemented cookies has also been reported by [3], [23]. Thereupon the BPP and PPP are considered a good source of fiber, ash while wheat flour considered a good source of protein and carbohydrates. Such results are nearly in according with these found by [9], [14], [24]. In general, it could be concluded that BPP or PPP utilized in improving the nutritional composition of cookies. Our results are in coincide with the results of [25], [26] and [3] who reported that BPP and PPP had high nutritive value as biomass, protein, cellulose, pectin and minerals.

3.2 Mineral composition of BPP or PPP and their supplemented cookies:

Results in (Table 4 and 5) showed minerals content of BPP and PPP as mg /100g DWB. This data indicated that BPP have highest amount of K, Ca, Mg, Na, Fe and Zn (mg / 100g) compared with PPP. A significant improvement was observed in all minerals (except Na) of cookies supplemented with BPP or PPP compared to control sample. Our results agree with [27] who reported that the bread containing 5 or 10% banana peel flour (BPF) had the highest K, Ca, Fe, Mn and Zn content compared with control bread, and [3] who noticed significant increase in Ca, K, Fe and Zn in supplemented cookies with PPP.

3.3 Total phenolic content and antioxidant activity of BPP or PPP and their supplemented cookies:

Results in (Table 6 and 7) show the total phenolic content in banana and pomegranate peels and their supplemented cookies. The results revealed that phenolic content in PPP are more abundant which reached to 110.70 mg GAE / g DW, when compared with BPP which reached to 11.59mg GAE / g DW. The total phenolic content and total flavonoid in banana peel ranged widely from 75.01 to 685.57 mg GAE/g and 39.01 to 389.33 mg GAE/ g DW respectively as reported by [6]. From the results (Table 6) total phenolic content of cookies were increased from 0.36 mg GAE to 2.47 mg /g with gradual increments of BPP concentration from 5 to 20%; also cookies supplemented with PPP at the same levels (Table 7) show that the phenolic content increased from 0.37 to 22.12 mg GAE /g. Results in (Table 6 and 7) show the antioxidant activity of BPP, PPP and their cookies extract. The results revealed that PPP had the highest value of antioxidant activity 237.31 DPPH (mg TE/g) compared with BPP (12.56 DPPH mg TE/g). Results of [28] found that the antioxidant activity as DPPH (mg TE/g) was clearly related to the total phenolic of peel powder extracts. Also cookies containing BPP or PPP at levels (5-20%) had significantly ($p<0.05$) higher total phenolic content and antioxidant activity than the control cookies.

3.4 Identification of phenolic compounds for ethanol extract of BPP and PPP by HPLC:

Phenolic compounds (µg/g) of the ethanol extracts of BPP and PPP were identified by HPLC; results are shown in (Table 8 and 9) and fig (1 and 2). In particular, the phenolic acid, cinnamic acid, caffeic, Rutin, p-coumaric, p-hydroxybenzoic, Protocatechuic were identified with values ranging from 16.26 µg/g to 5.77 for BPP (Table 8) and fig (1); also, Rosmarinic, Cateachin, Gallic and Apigenin with values ranging from 2.9 to 1.89 µg/g. Meanwhile, Chrysin, Kaempherol, Qurecetin, Syringic and Vanillic acid were at low values ranging from 1.89 µg/g to 0.43 µg/g. Data in Table (9) and fig (2) show that the ethanol extract of PPP was rich in Gallic acid (3843.96 µg/g) followed by Ellagic acid 2494.63 and cateachin (149.38 µg/g). Meanwhile, p-hydroxybenzoic, Vanillic, ferurlic, Cinnamic, Rutin, and then Apigenin-7-glucoside were found in small amounts with ranging from 52.65 to7.76 µg/g. These results are in agreement with those obtained by [29] and [30] who reported that gallacatechin was isolated (using HPLC) from the banana peel extract which showed strong antioxidant activity. Also, the phenolic acids identified in dried PP include p-coumaric, Cateachin, Rutin, ellagitanin. Moreover, [15] reported that these poly phenols are responsible for the antioxidant properties of PP extract.

3.5 Sensory evaluation of cookies supplemented with BPP or PPP:

Sensory evaluation was carried out in order to evaluate taste, color, odor, texture and overall acceptability of cookies supplemented with different levels of BPP or PPP at zero time. Results reported in (Table 10 and 11) show the mean values score of sensory characteristics of cookies formulated with powder of BPP or PPP immediately after processing (zero time). The results score revealed that the cookies formulated with BPP or PPP at 5% was significantly superior in all quality attributes compared to sample formulated with 10 to 20% of BPP and PPP. According to Table (11) cookies formulated with PPP at 5% revealed that taste, color, odors were closed to the consumer preference of control. Whereas, all the other attributes in cookies

supplemented with15 to 20% PPP were significantly reduced than the control samples. These means that the addition of BPP or PPP to cookies was not accepted in concentrations more than 10 %. In general, it could be concluded that BPP or PPP could be utilized in improving the sensory characteristics of cookies at low concentration. The odor and acceptability score of cookies supplemented with BPP or PPP were affected if the level of powder increased than 10%. This result is similar to that obtained by [31] who noted that the formulation of bread substituted with 10% of BPF (banana pseudo-stem flour) was comparable to the control bread in terms of the overall acceptability. Also, [27] noted that the bread prepared by replacing 5% and 10% of banana peel (BP) is found to be sensorially acceptable. Otherwise, the obtained results are nearly in according with those found by [24] and [9] who found that sensory of ban bread supplemented with 1% PP (pomegranate peel) seemed to be more closed to the control sample than the other samples (2 or 5% PP).

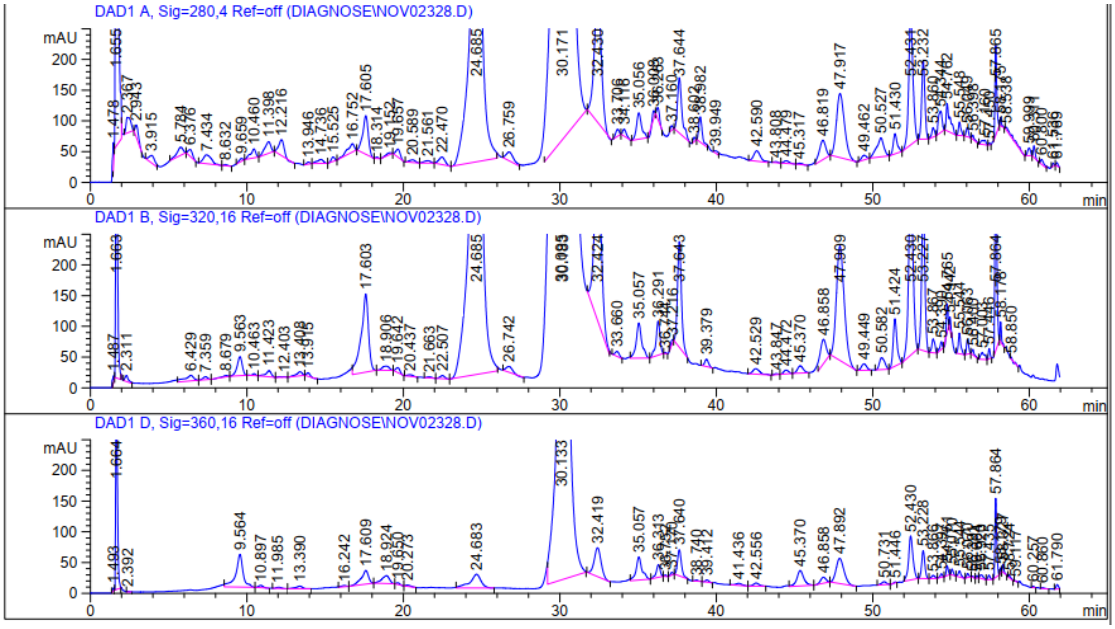

Fig.1 Polyphenols Composition in Peels of Banana by HPLC Quantification analysis (µg/g)

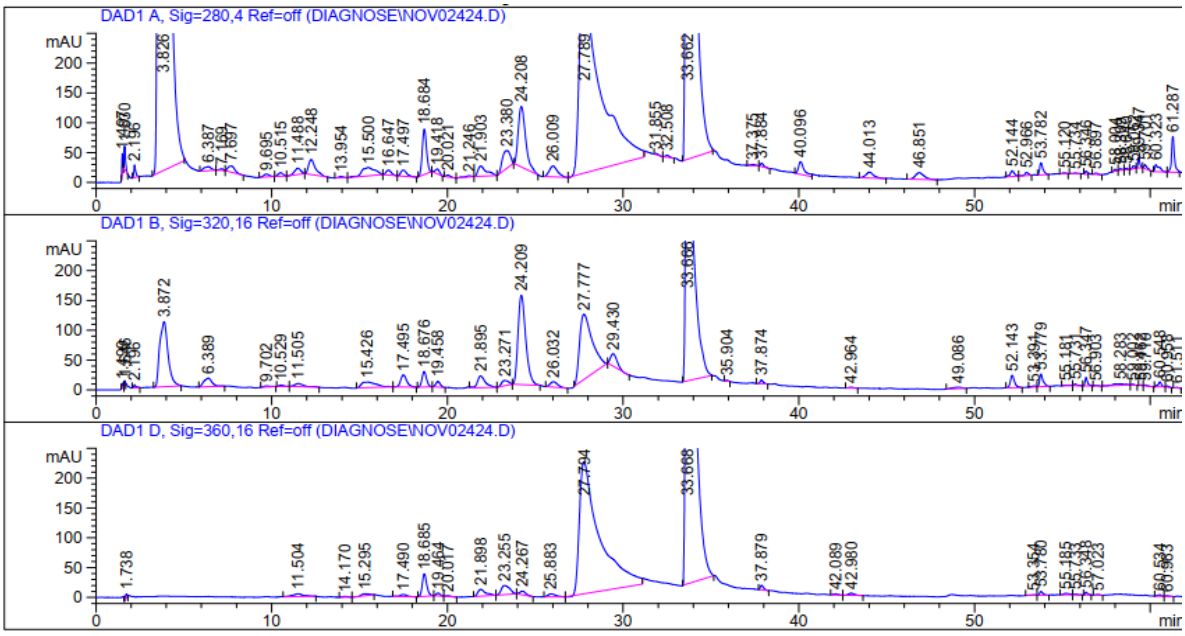

Fig 2 Polyphenols Composition in Peels of pomegranate by HPLC Quantification analysis (µg/g)

Table 1 :Formulas of cookies with different levels of pomegranate and banana peel powder

Treatments	Components (g)					
	Pomegranate or banana Peels powder	Wheat flour (72%)	Sugar	Fresh whole egg	Hydrogenated Vegetable Ghee (H.V.G)	Baking powder
Control	-	500	250	180	250	10
5% Pomegranate or banana peels	25	475	250	180	250	10
10% Pomegranate or banana peels	50	450	250	180	250	10
15% Pomegranate or banana peels	75	425	250	180	250	10
20% Pomegranate or banana peels	100	400	250	180	250	10

Table 2 :Nutritional composition of banana peel and their supplemented cookies (g/100g) on dry weight basis

Samples	protein	fat	ash	fiber	Carbohydrate*
BPP	8.53c±0.025	4.44f±0.015	16.19a±0.016	14.03a±0.025	56.81e±0.026
control cookies	8.83a±0.015	25.84a±0.017	1.04f±0.015	0.55f±0.026	63.73d±0.026
Cookies+BPP 5%	8.74b±0.006	24.05b±0.450	1.66e±0.030	1.13e±0.036	64.42a±0.062
Cookies+BPP 10%	8.47d±0.025	22.97c±0.020	2.49d±0.011	1.86d±0.035	64.22b±0.062
Cookies+BPP 15%	8.45d±0.031	21.87d±0.020	3.24c±0.020	2.47c±0.020	63.97c±0.050
Cookies+BPP 20%	8.24e±0.010	20.84e±0.036	3.98b±0.026	3.18b±0.020	63.76d±0.011

Mean values in the same column followed by different alphabets are significantly different (P <0.05), mean ± SD.
*By difference

Table 3:Nutritional composition of pomegranate peel and their supplemented cookies (g/100g) on dry weight basis

Samples	protein	fat	ash	fiber	Carbohydrate*
PPP	4.82d±0.095	2.16f±0.171	4.35a±0.015	14.61a±0.045	74.05a±0.152
control cookies	8.83a±0.015	25.84a±0.017	1.04f±0.015	0.55f±0.026	63.73e±0.026
Cookies+PPP5%	7.83b±0.061	24.03b±0.066	1.27e±0.200	2.25e±0.036	64.61d±0.040
Cookies+PPP10%	7.80b±0.170	23.11c±0.045	1.49d±0.010	2.93d±0.025	64.68d±0.181
Cookies+PPP15%	7.73b±0.079	22.16d±0.153	1.59c±0.010	3.54c±0.015	64.98c±0.133
Cookies+PPP20%	7.51c±0.075	20.92e±0.126	1.77b±0.010	4.27b±0.057	65.52b±0.020

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.
*By difference.

Table 4:Mineral composition of banana peel powder and their supplemented cookies (mg /100 g on DWB)

Samples	K	Ca	Na	Mg	Fe	Zn
BPP	5036.08a±0.137	569.33a±0.421	284.48f±0.241	359.31a±0.290	11.15a±0.015	4.31a±0.118
Control cookies	90.23f±0.110	100.38f±0.232	306.40a±0.260	54.41f±0.405	0.43f±0.010	1.34c±0.095
Cookies+BPP 5%	335.69e±0.132	122.51e±0.276	303.34b±0.419	68.74e±0.075	0.88e±0.020	1.33c±0.121
Cookies+BPP 10%	582.77d±0.373	146.42d±0.306	301.74c±0.270	84.33d±0.359	1.40d±0.011	1.53b±0.144
Cookies+BPP 15%	830.70c±0.494	169.57c±0.321	300.54d±0.382	99.49c±0.201	1.92c±0.006	1.55b±0.050
Cookies+BPP 20%	1077.63b±0.445	193.36b±0.240	299.37e±0.387	114.43b±0.182	2.47b±0.012	1.71b±0.020

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.

Table 5:Mineral composition of pomegranate peel powder and their supplemented cookies (mg/100g on DWB)

Samples	K	Ca	Na	Mg	Fe	Zn
PPP	1034.25a±0.035	266.34a±0.203	257.26f±0.707	111.55a±0.450	2.47a±0.012	1.38a±0.011
control cookies	90.23f±0.110	100.38f±0.232	306.40a±0.260	54.41f±0.405	0.43f±0.010	1.34a±0.095
Cookies+PPP5%	135.35e±0.050	107.60e±0.440	301.75b±0.287	55.90e±0.446	0.49e±0.100	1.34a±0.095
Cookies+PPP10%	182.54d±0.036	116.59d±0.331	300.47c±0.323	58.66d±0.397	0.57d±0.011	1.34a±0.095
Cookies+PPP15%	229.68c±0.020	124.40c±0.258	297.86d±0.176	61.31c±0.295	0.62c±0.006	1.35a±0.021
Cookies+PPP20%	276.77b±0.025	132.55b±0.255	295.73e±0.462	64.58b±0.370	0.73b±0.015	1.35a±0.021

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD

Table 6:Total phenolic contents and antioxidant activity of BPP and their supplemented cookies

samples	**Total phenolic contents (mg GAE/g)**	**Antioxidant Activity DPPH (mg TE/g)**
BPP	11.59a±0.035	12.56a±0.63
control cookies	0.36f±0.011	0.38d±0.01
Cookies+BPP 5%	0.76e±0.017	0.41d±0.02
Cookies+BPP 10%	1.30d±0.006	0.66c±0.11
Cookies+BPP 15%	1.88c±0.015	1.04b±0.05
Cookies+BPP 20%	2.47b±0.037	1.15b±0.14

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.

Table 7:Total phenolic contents and antioxidant activity of PPP and their supplemented cookies

samples	Total phenolic contents (mg GAE/g)	Antioxidant Activity DPPH (mg TE/g)
PPP	110.70a±0.03	237.31a±1.92
control cookies	0.36f±0.01	0.38f±0.030
Cookies+PPP5%	5.72e±0.08	11.48e±1.38
Cookies+PPP10%	11.20d±0.09	21.84d±1.05
Cookies+PPP15%	16.27c±0.08	33.51c±1.50
Cookies+PPP20%	22.12b±0.10	45.72b±0.99

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.

Table 8:HPLC Quantification analysis (µg/g) of polyphenols Compounds in Banana peels extract

Gallic	2.14
Protocatechuic	5.77
p-hydroxybenzoic	5.96
Cateachin*	2.88
Caffeic	15.02
Syringic	0.46
Vanillic	0.43
p-coumaric	7.81
Rutin*	12.39
Rosmarinic	2.90
Cinnamic	16.26
Qurecetin	0.59
Apigenin*	1.89
Kaempferol*	0.60
Chrysin*	0.76

*flavonoids

Table 9:HPLC Quantification analysis (µg/g) of polyphenols Compounds in pomegranate peels extract

Gallic	**3843.96**
Protocatechuic	23.46
p-hydroxybenzoic	52.65
Cateachin*	149.38
Caffeic	14.01
Syringic	2.35
Vanillic	17.92
Ferulic	14.58
Ellagic	2494.63
Rutin*	9.9
Apigenin*	7.76
Cinnamic	13.09
Kaempferol*	1.74

Table10:Sensory evaluation scores of cookies supplemented with different levels of banana peel powder (BPP).

samples	taste	color	odor	texture	acceptability
control cookies	8.90a±0.316	8.90a±0.316	8.50a±0.527	8.90a±0.316	8.90a±0.316
Cookies+BPP5%	8.40b±0.516	8.40b±0.516	8.40a±0.699	8.30b±0.483	8.30b±0.675
Cookies+BPP10%	7.40c±0.516	8.00b±0.471	7.30b±0.675	8.10b±0.316	7.00c±0.666
Cookies+BPP15%	6.90d±0.568	7.40c±0.516	6.80b±0.632	7.30c±0.483	6.90c±0.738
Cookies+BPP20%	5.90e±0.568	6.90d±0.568	5.50c±0.527	6.10d±0.568	6.80d±0.788

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.

Table11.:Sensory evaluation scores of cookies supplemented with different levels of pomegranate peel powder (PPP).

samples	taste	color	odor	texture	acceptability
control cookies	8.90a±0.316	8.90a±0.316	8.50a±0.527	8.90a±0.316	8.90a±0.316
Cookies+PPP5%	7.90b±0.568	8.30b±0.675	7.90b±0.738	7.50b±0.527	7.50b±0.527
Cookies+PPP10%	6.40c±0.516	7.50c±0.527	7.40b±0.516	6.80c±0.632	7.00c±0.666
Cookies+PPP15%	5.30d±0.483	5.40d±0.516	6.30c±0.483	5.30d±0.483	5.20d±0.421
Cookies+PPP20%	3.10e±0.568	5.00d±0.483	5.50d±0.527	4.90d±0.316	4.80d±0.632

Mean values in the same column followed by different alphabets are significantly different (P < 0.05), mean ± SD.

4. Conflicts of interest

There are no conflicts to declare.

5. References

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