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UTILIZATION OF POMEGRANATE AND ORANGE PEELS TO PREPARE HEALTHY CAKES

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ABSTRACT

Agricultural by-products originated from food processing factories represented one of the permanent environmental problems. New trends were raised to utilize these valuable wastes full of nutraceuticals and phytochemicals. Pomegranate (PPP) and orange peels (OPP) were used in the current study to assess their beneficial effects. The counts of microorganism were determined and found in the safe permitted level in food.Afterward peels were directed to prepare bakery products.Pomegranate peel contained iron, zinc, calcium, potassium, magnesium, phosphorus and sodium at levels of 12.75, 5.9, 202.7, 135.8, 45.46, 66.38 and 38.91 mg/100g dry matter, respectively. Orange peel valued 19.5, 6.7, 635.8, 785.9, 91.4, 57.55 and 32.34 mg/100g dry matter, respectively. Pomegranate peel contained vitamins B_1 and D_3 at levels of 0.014 g/Kg and 0.023 MIU/kg, respectively. While, in orange peel were 0.027 g/kg and 0.019 MIU/kg, respectively. Pomegranate peel had total, soluble and insoluble dietary fiber contents of 19.7%, 5.8% and 13.9%, respectively. Whereas, orange peel registered 33.9%, 6.5% and 27.4%, respectively. GC/MS analysis of orange peel showed the existence of Dihydrocarvone (30.25%) and 4',6-Dimethoxyisoflavone-7-O-β-D-glucopyranoside (20.83%). Phloroglucinol (28.52%), (S)-(-)-Citronellic acid (14.24%) werethe bioactive compounds. Sensory evaluation for overall acceptability showed that non-significant difference existed between T1 (Control); T2 (10%PPP) and T5 (10%OPP).The chemical composition of the resulting cake showed that by increasing the substitution levels of either PPP or OPP, the ash and dietary fiber content increased, the available carbohydrate and fat content decreased and the protein content was not affected compared to the control without addition. The decrease in caloric values ranged between 404.34-420.59 kcal/100 g compared to 453.66 kcal/100 g for the control sample. It was found that by increasing the replacement ratios, the texture properties were affected and the microbial content of the resulting cake samples decreased, which gives an indication of the possibility of increasing the preservation period. The results indicated that PPP and OPP by-products can serve as a good source of bioactive components. It could be recommended that incorporation of the mentioned raw material with wheat flour 72% extraction to obtain healthy bakery productshave high biological value.

Keywords : Pomegranate peel, orange peel, GC/MS, cake, microbial load, physical properties

Introduction

Pomegranate and orange peels are generated from industrial food factories. Kumar *et al*. (2017) declared that huge amount of fruit and vegetable residues by-products from food sector industry increased continuously. Varzakas *et al*. (2016) pointed to the usefulness of plant residues containing bioactive phytochemicals related to health management. They reduce risk of chronic diseases, and could be directed to food-related industries (Kiokias *et al.*, 2016). Preedy*et al.* (2011) showed that fortification of wheat flour with fruit seeds in pastry products increase the final product value. Fruit peels and seeds had insecticidal, antifungal properties and extended shelf life of bakery products (Divina, 2016). Kandasamy and Shanmugapriya (2015) found that fruits are great source of vitamins, minerals, sugars, soluble dietary fiber and phyto-nutrients.Antioxidant, anti-cancer, and anti-inflammatory properties of pomegranate peel were directed to treatment of hyperlipidemia, diabetes, obesity, cancer, cardiovascular disease, diabetes, dental conditions, bacterial infection, skin and liver damage (Seeram *et al.,* 2006 and Sharma and Maity 2010). Kandasamy and Shanmugapriya (2015) found that fruits are great source of vitamins, minerals, sugars, soluble dietary fiber and phyto-nutrients. The study aimed to determine total dietary fiber, phenolic and flavonoid contents, mineral profile, thiamine and cholecalciferol content of pomegranate and orange peels. Also, GC/MS analysis of peels powder was carried out to identify active phytochemicals. Additionally, the possibility of using these natural food processing by-products in preparing healthy bakery products such as cake. Microbial load was examined to prolong shelf life of cake under preservation conditions.

Materials and Methods

Pomegranate and orange peels were obtained from Guhayna Factory, Giza during 2017 and 2018. Cake ingredients such as wheat flour (extracting rate 72%), sugar, salt, vanilla, baking powder, milk and oil were purchased from local market at Cairo.

Preparation of pomegranate peels powder (PPP):

Pomegranate peel was rinsed with distilled water, dried at 60°C for 12 hours. The dried powder was grinded using electric blender into fine powder and stored refrigerated until use (Saker *et al.*, 2012).

Preparation of orange peels powder (OPP):

Orange peel was washed, cut into small pieces, dried at 50°C for 24 hours. The dried powder was grinded using electric blender into fine powder and stored refrigerated until use (Figuerola *et al.*, 2005).

Microbiological examination of raw materials:

Dried samples of pomegranate peel powder (PPP) and orange peel powder (OPP) were examined for total plate count (TPC), total coliform count (TCC), fecal coliform count (FCC), *Salmonell*a (Sal), *Bacillus cereus* (BC) and total fungal count (TFC) according to NMKL (1994).

Chemical analysis:

Moisture, protein, fat, ash and crude fiber contents were determined according to the methods described by A.O.A.C. (2005). Available carbohydrates (A.C) were calculated by difference according to the following equation:

*A.C (*on dry weight basis) *=100- + %protein + % total lipid+ % ash+ % fiber).*

Caloric value was calculated according to the following equation (FAO/WHO, 1974):

Caloric value = 4 (protein% + Carbohydrate %) + 9 (fat %).

Total, insoluble and soluble dietary fibers were determined according to AOAC (2005).

Determination of minerals

Iron (Fe), zinc (Zn), calcium (Ca), potassium (K), magnesium (Mg), phosphorus (Pb) and sodium (Na) were determined according to AOAC (2019).

Determination of vitamins B1 and D3

Thiamin (B1) and colecalciferol (D3) were determined according to AOAC (2000).

GC/MS analysis of peels:

Identification of active phytochemicals was conducted by GC/MS technique using GC (Agilent Technologies 7890A) interfaced with a mass-selective detector (Agilent 7000) equipped with a polar Agilent HP-5ms (5%-phenyl methyl polysiloxane)

Cake preparation:

Seven types of cake were prepared, type one Control (T1) consists of these ingredients Wheat flour 72% extraction rate (100g), sugar (100 g), egg (1), Oil (75ml), Milk (as require), vanilla (2g), baking powder (3g) and salt (1g). The powder of pomegranate peel (PPP) was added at the levels substitution of 10, 20 and 30% from wheat flour to obtained type two (T2) 10%PPP (10g PPP + 90g flour), typethree (T3) 20%PPP (20 g PPP +80g flour) and type four (T4) 30% PPP (30 g PPP +70g flour). The powder of orange peel (OPP) was added at the levels substitution of 10, 20 and 30% from wheat flour to obtained type five (T5) 10% OPP (10g OPP +90g flour), type six (T6) 20%OPP (20g OPP+80g flour) and typeseven (T7) 30% OPP (30g OPP+70g flour). And the rest of the ingredients, such as the control sample, according to the difference in the amount of milk.A mixture of egg with sugar and oil works, then beat with an electric beater, and pur all the dry ingredients together and add the milk until we reach the desired consistency of the cake.Baked at oven-180°C for 35 min cakes were allowed to cool for 2 h and then removed from the trays. The cakes were packed into separate polypropylene containers and stored at room temperature (between 20 to 25°C) for two weeks.

Physical properties of prepared cakes:

Physical properties of produced cakes were determined according to A.A.C.C. (2002). Height and weight of cakes were determined individually within one hour after baking, the average was recorded. Volume (Cm^3) of produced samples was determined by the displacement of rape seeds. Specific volume (cm3/g) of cakes were calculated as follows:

$$\text{Specific volume} = \frac{\text{Volume}\left(\text{cm}^3\right)}{\text{Weight}\left(\text{g}\right)}$$

Water activity (aw):

Water activity (aw) of produced cakes were measured using rotronic Hygro Lab EA10-SCS (Switzerland). All samples were broken into small pieces immediately before water activity measurement according to (Samsudin *et al.,* 2019).

Texture Analyser:

The texture profile analysis (TPA) of cakes were conducted using CT3 Texture Analyzer (Version 2.1, 10000 Gram unit, Brookfield, Engineering Laboratories, Inc. USA). According to A.A.C.C. (2000) in terms of hardness(N), cohesiveness, Gumminess (N), Chewiness (mj),Adhesiveness (mj), springiness (mm) and Resilience of the samples. The samples (2.5 cm height and 4 cm diameter) were compressed twice to 40% of the original height using settings as Test-TPA, Probe-36 mm Cylindrical, Pre-test speed-2mm/s, Test speed-2 mm/s, Post-test speed-2mm. The experiments were conducted under ambient conditions.

Microbial analysis of produced cakes

Total plate count (TPC), mold and yeast were determined three times in cakes upon preparation at zero time, seven and fourteen days according to the procedure described by AOAC (2005).

Statistical Analysis of data

Statistical analysis was performed using computer program ANOVA one way (SPSS, 2000). All data were expressed as mean ±SD.

Results and Discussion

Evaluation of microbial load of raw materials:

Data Parameters *E. coli*, *Salmonella*, *Staphylococcus aurues and Bacillus ceureus.* Total coliform count and fecal coliform count PPP and OPP were free from pathogenic bacteria: weren't detected. (ND)= Not Detected. Total fungal count of OPP and OPP were 2×10^2 and 5×10^4, respectively. OPP had total plate count of 4×10^3.As a result, the counts of microorganism were considered in the safe permitted level in food (Rodrigues Batista *et al.,* 2016 and Liu *et al*., 2018). Consequently these samples are safe for preparation of healthy food.

Chemical composition of used raw materials:

Proximate chemical analysis of pomegranate peel powder (PPP) revealed that moisture, protein, fat, fibers, ash and available carbohydrate contents were 11.9, 4.2, 4.8, 8.6, 3.2 and 79.2%, respectively. Moisture content of orange peel, protein, fat, fibers, ash and available carbohydrate contents were 10.6, 6.7, 4.7, 9.52, 3.05 and 76.03% respectively (Table 1).

Pomegranate peel contained iron, zinc, calcium, potassium, magnesium, phosphorus and sodium at levels of 12.75, 5.9, 202.7, 135.8, 45.46, 66.38 and 38.91 mg/100g dry matter, respectively.

Iron, zinc, calcium, potassium, magnesium, phosphorus and sodium concentrations in orange peel are 19.5, 6.7, 635.8, 785.9, 91.4, 57.55 and 32.34 mg/100g dry matter, respectively (Table 1).

Results ensured that calcium content of pomegranate peel was 202.7 mg/100g DW, while orange peel was higher and valued 635.8 mg/100g DW.

Calcium is important for bones and teeth health and is involved in the regulation of nerve and muscle functions (Soetan *et al.,* 2010).

Pomegranate and orange peels are good sources of vitamin B_1 (thiamine) and D_3 (Cholecalciferal) as presented in Table (1). Pomegranate peel is packed with dietary fiber (total, soluble and insoluble fiber) much more than orange peel.

Table 1 : Chemical composition. Mineral content. Vitamin and Fiber contents of pomegranate Peel powder (PPP) and orange peels (OPP).

Analysis	Pomegranate peel	Orange peel
Moisture (%)	11.9	10.6
Protein (%)	4.2	6.7
Fat (%)	4.8	4.7
Fibers (%)	8.6	9.52
Ash (%)	3.2	3.05
Available Carbohydrate (%)	79.2	76.03
Iron (mg/100g)	12.75	19.5
Zinc (mg/100g)	5.9	6.7
Calcium (mg/100g)	202.7	635.8
Potassium (mg/100g)	135.8	785.9
Magnesium (mg/100g)	45.46	91.4
Phosphorus (mg/100g)	66.38	57.55
Sodium (mg/100g)	38.91	32.34
Thiamine (Vitamin B_1) (g/Kg)	0.014	0.027
Colcalciferol (Vitamin D_3) (MIU/Kg)	0.023	0.019
Total dietary fiber (%)	19.7	33.9
Soluble dietary fiber (%)	5.8	6.5
Insoluble dietary fiber (%)	13.9	27.4

Values are average of triplicate determination

GC/MS analysis of orange peel powder:

Area sum (%)**,** compound name and retention time (RT) were illustrated Orange peel chromatogram showed the existence of 26 compounds The most predominant were: Dihydrocarvone (30.25%), 4',6-Dimethoxyisoflavone-7-O-β-D-glucopyranoside (20.83%), Isolongifolol (6.66%), Quercetin 3',4',7-trimethyl ether (5.99%), 2,3,4,6-Tetramethylphenol (4.09%), 5,7,3',4',5'-Pentahydroxyflavone (4.02%).

GC/MS analysis of pomegranate peel powder:

GC/MS analysis of pomegranate peel powder is shown Twenty seven compounds were identified. The major bioactive compounds were reported to be: phloroglucinol (28.52%), (S)-(-)-Citronellic acid (14.24%), cis-13-Octadecenoic acid (7.02%), Methylmalonic acid (6.59%), Gallic acid (5.61%), Endo-Borneol (3.59%).

Pomegranate peel is a good source of natural antioxidants that increase the shelf life of products by retarding spoilage of foods (Singh *et al.,* 2001).

Sensory evaluation of different types cake:

Sensory evaluation is considered as an important indicator of potential consumer preferences, In spite of its short comings it will remain one of the most reliable quality assessment technique for food and food products in general and for bread and bakery products in particular (Stone, 2012).

Sensory evaluation is were shown in Table 2: Statistical analysis of overall acceptability were showed that non significant difference were existed between T1 (Control): T2 (10%PPP); T5 (10%OPP); (92.45 %, 90.85%, 90.32%); T4 (30%PPP); T7(30%Opp) (82.68%, 80.49%) and T3,(20%PPP) T6 (20%) (87.77%, 85.74%). Addition of 10% PPP and OPP it's got the very good acceptance. in cakes. These results are similar to results of Samsudin *et* a*l.* (2019).

Table 2 : Sensory evaluation of prepared cakes.

Type Cake	Crust color	Crumb color	Crumb distribution	Odor	Taste	Appearance	Over all acceptability
	15	15	15	15	20	20	100
T1	14.40[a]± 0.10	14.50± 0.10 [a]	13.5 [a]± 0.35	13.80[ب]± 0.17	18.79[a]±0.19	17.46[c]± 0.15	92.45[a]±0.79
T2 10%	14.90[a]± 0.10	14.46[a]±0.45	11.89[d]± 0.09	13.70[c,ب]±0.10	17.50[c]±0.11	18.40[a]±0.13	90.85[bc]± 0.34
T3 20%	14.75[a]±0.15	14.75[a] ±0.12	11.88[e]±0.07	13.86[a]±0.05	16.73[d]±0.20	15.80[d]±0.10	87.77[d]±0.37
T4 %30	14.36[a] ± 0.47	14.76[a]±0.15	11.83[f]±0.05	13.80[b]±0.10	15.70 [f]±0.17	12.23[f] ± 0.23	82.68[f]±0.50
T5 10%	14.39[a]± 0.10	14.5[a] ±0.10	12.23[b] ±032	13.50[e]. ±0.13	18.20[b]± 0.21	17.5[b]± 0.26	90. 32[c]±0.46
T6 20%	14.46[a]± 0.15	14.76[a] ±0.15	11.83[f] ± 0.05	13.63[d]± 0.15	15.80[e]±0.10	15.26[e]±0.25	85.74[e]±0.20
T7 30%	14.82[a]± 0.06	14.85[a]±0.05	11.90[c]± 0.10	13.40[f]± 0.10	13.56[g]±0.49	11.96[g] ±0.05	80.49[g] ± 0.52

PPP= Pomegranate peel powder, OPP= Orange peels powder. Each value with the same column is followed by the same letters is not significantly different at level of 0.05.

Chemical composition of different types cake:

The chemical composition of the cake produced as affected by different replacement levels (10, 20 and 30 %) of PPP or OPP waste comparing to control sample (without addition) was tabulated in table (3), it could be noticed that the non-significant difference were found in protein content of all samples of cake compared with the control. Cake containing PPP or OPP had the highest value of ash and crud fiber and lowest value of available carbohydrate and total caloric value compared with the control. All samples of cake except the control had fat content ranged from 8.26-9.56%, ash 3.1-4.7%, crud fiber 2.94-4.56%, available carbohydrate 75.05-78.28 % and total caloric value 404.34- 420.59 K.cal. The control had fat 12.30%, ash 1.03%, crud fiber 0.93%, available carbohydrate 79.18% and caloric value 453.66 K.cal. The rate of decrease in total caloric for samples was ranged from 6.69 to 10.87K.cal. It is clearly noticed that the combination of wheat flour (72% extraction) with PPP or OPP powder as a flour substitution caused an increase in crude fiber, ash and reduced the available carbohydrate in the mixed flour. These results are nearly in accordance with those obtained by Mohamed *et al*. (2016).

Table 3 : Chemical composition of cake preparation with different levels of PPP and OPP (%on dry weight basis).

components	Produced cake with						
	Control	PPP at substitution levels of			OPP at substitution levels of		
		10%	20%	30%	10%	20%	30%
Protein	6.56[a] ± 0.15	6.73[a] ±0.20	6.83[a] ±0.20	6.93[a] ±0.07	6.83[a] ±0.25	7.06[a] ±0.15	7.06[a] ±0.20
Fat	12.3 [a] ±.12	8.95[bcd] ±0.2	8.83[cd] ±0.4	8.26[d] ±0.12	9.56[b] ±0.10	9.13[bc] ±0.12	8.63[cd] ±0.15
Ash	1.03[d] ±.011	3.1[c] ±0.11	3.8[b] ±0.12	4.36[a] ±0.11	3.36[c] ±0.20	4.4[a] ±0.20	4.7[a] ±0.3
Crude Fiber	0.93[d] ±0.07	2.94[e] ±0.04	3.63[b] ±0.25	4.23[a] ±0.25	3.0[c]± 0.10	3.8[b] ±0.36	4.56[a] ±0.20
Available carbohydrate	79.18[a] ±0.13	78.28[a] ±0.01	76.91[b] ±0.14	76.22[c] ±0.12	77.25[ab] ±0.12	75.61[e] ±0.13	75.05[d] ±0.12
Calorric value Kcal/100gm)	453.66	420.59	414.43	404.34	422.36	412.85	406.11

Physical properties of cake prepared with PPP or OPP:

Non-significant difference ($p>0.05$) in height (cm) and specific volume (cm^3/g) existed between control cake and cakes prepared with 10% and 20% PPP or 10% and 20% OPP. While, a significant difference ($p<0.05$) existed between cakes prepared with 30% PPP and 10% or 20 % PPP. There is a significant increase ($p\leq0.05$) in weight (g) between 10% PPP and 20% or 30% PPP. It was clear that usage of 10% PPP and 20% or 30% pomegranate or orange peels led to increase in cakes weight (51.43, 53.63, 57.76 g or 51.96, 53.4, 58.00 g, respectively). Our results are in agreement with Doweidar *et al.* (2010).

Texture profile analysis of cakes prepared with PPP or OPP:

The results in Table 4: showed that hardness, chewiness and Gummines were increased in all treatments. The hardness of the fresh cake (at zero time) was increased from 15.27N in control to 17. 7 N, 20.08 N and 24.17 respectively after addition of 10% PPP (T1), 20% PPP (T2) and 30% (T3) respectively. After two weeks of the storage period at room temperature, the hardness increased from 26.39 N in control to 29.10, 36.66 and 37.18N respectively after addition 10% PPP 20% and 30% PPP respectively. Mehmet and Halis, (2008) my results agree with him. These Cohesiveness and Resilience. The opposite decrease over time.

Table 4 : Effects of adding pomegranate and orange peels powder on texture profile analysis (TAP) of produced Cake.

Characteristics	Storage Time	Control	Pomegranate peel powder (PPP)			Orange peel powder (OPP)		
			T1 10%	T2 20%	T3 30%	T4 10%	T5 20%	T6 30%
Hardness (N)	Zero time	15.27	17.70	20.08	24.17	18.60	20.70	26.70
	1week	17.50	27.80	29.90	29.92	28.38	39.00	39.10
	2week	26.39	29.10	36.66	37.18	29.34	44.85	58.03
Cohesiveness	Zero time	0.88	0.75	0.66	0.42	0.79	0.60	0.51
	1week	0.85	0.70	0.47	0.28	0.68	0.48	0.45
	2week	0.69	0.51	0.45	0.18	0.53	0.43	0.35
Gummines (N)	Zero time	13.81	14.08	14.20	16.61	14.67	17.48	22.38
	1week	16.98	20.33	22.02	25.78	18.47	19.45	25.86
	2week	18.29	20.33	22.55	25.97	19.81	20.20	28.7
Resilience	Zero time	0.45	0.37	0.32	0.15	0.27	0.27	0.23
	1week	0.27	0.21	0.20	0.10	0.23	0.14	0.14
	2week	0.25	0.16	0.15	0.07	0.21	0.14	0.13
Chewiness (mj)	Zero time	51.4	68.02	70.06	74.61	66.66	66.80	66.93
	1week	66.68	69.64	76.00	78.73	66.93	66.98	76.0
	2week	70.60	73.16	75.92	79.37	74.11	75.20	75.59
Adhesiveness (mj)	Zero time	0.00	0.20	0.20	0.35	6.30	6.40	6.50
	1week	0.30	0.40	0.42	0.47	9.00	9.30	9.50
	2week	0.40	0.70	0.73	0.75	10.00	10.30	10.70

Changes in moisture content and water activity (a_w) during storage at room temperature (25±5 ^{0}C) of cakes

For T1, T3,T5 and T6, non-significant difference in water activity at zero time and after 7 days during storage at room temperature, whereas a significant difference existed after 14 days. For T1, T2, T3,T4, T5, T6 and T7, there was a significant difference in water activity existed at zero time,7 days and 14 days Table 5:

The data revealed that high moisture content (24.70%) was recorded for Control show the changes in moisture content in all treatments during storage period of cakes at room temperature, of the fresh cakes (at zero time) was decreased from 24.70 in control to 17.46 and 18.80 after addition of 10%PPP and 20%PPP respectively, after addition of 10% OPP 21.30 and 22.77 and 20% OPP respectively. The higher the fiber content, the higher the moisture, that addition in formulation of cake samples significantly Table 5: shows the moisture contents (MC%) and water activities ($_a$w) in This results in water activities ($_a$w) in all treatments during storage period of cakes at room temperature, of the fresh cakes (at zero time) was decreased from 0.828, in Control 0.817 and0.817 after addition of 10%PPP and 20%PPP respectively. This percentage (10, 20%) led to extending shelf life of cakes during storage at room temperature up for to 14 day

Table 5: shows the moisture contents (MC%) and water activities ($_a$w). It was clear that maintaining low moisture content and reduced water activity increased shelf-life of bakery products (Samsudin *et al.*, 2019).

Table 5: Moisture contents (MC%) and water activities (a_w) of prepared

Treatments	water activities (a_w)			Moisture content		
	Storage period week			Storage period week		
Cake	Zero time	first week	Second week	Zero time	first week	Second week
Control	0.828^{a}±0.004	0.816^{a}±0.002	0.810^{a}±0.003	24.70^{a}±0.14	24.05^{a}±0.07	23.85^{a}±0.21
10%PPP	0.817^{ab}±0.001	0.803^{b}±0.001	0.792^{ab}±0.001	17.46^{b}±0.07	17.25^{c}±0.10	$16..45^{a}$±0.21
20%PPP	0.817^{ab}±0.001	0.798^{c}±0.001	0.750^{c}±0.001	18.80^{b}±0.53	18.45^{c}±0.07	18.45^{a}±0.07
30%PPP	0.783^{b}±0.001	0.762^{f}±0.001	0.717^{d}±0.002	22.85^{ab}±0.28	21.55^{b}±0.14	21.42^{a}±0.07
10%OPP	0.816^{ab}±0.001	0.803^{b}±0.001	0.792^{ab}±0.001	21.30^{ab}±0.14	20.55^{b}±0.32	19.65^{a}±0.70
20% OPP	0.805^{ab}±0.001	0.802^{b}±0.001	0.787^{b}±0.003	22.77^{ab}±0.07	21.25^{b}±0.07	19.61^{a}±0.26
30%OPP	0.791^{c}±0.002	0.788^{d}±0.002	0.715^{d}±0.002	23.65^{a}±0.13	22.70^{ab}±0.32	22.5^{a}±0.21

control T1); PPP (Pomegranate peel powder T210%,T3 20% ,T4 30%); OPP (Orange peel powder powder T5 10% , T6 20% ,T730%). Data are means of ± SD same letters indicate non-significant difference ($p \leq 0.05$).

The microbial aspects of cake stored:

The data in Table (6) indicate that TPC**,** mold and yeast were not detected of zero time and 7 days for all treatment For T1 (control), TPC valued (3×10^2) after 14 days of storage. Values for mold and yeast tested in T1, T2 and T5 were 8×10, 3 ×10 and 2×10 respectively after 14 days. These results are considered in safe level permitted in bakery product as reported by FDA (2013) that level of yeast and molds count ranged < 10^2.

Table 6: The microbial aspects of cake stored at 25 ^{0} C for 14 days

Test types	Test time	T1	T2	T3	T4	T5	T6	T7
TPC	Zero	ND	ND	ND	ND	ND	ND	ND
	First week	ND	ND	ND	ND	ND	ND	ND
	Two week	3×10^2	ND	ND	ND	ND	ND	ND
Mold and yeast	Zero	ND	ND	ND	ND	ND	ND	ND
	First week	ND	ND	ND	ND	ND	ND	ND
	Two week	8× 10	3 ×10	ND	ND	2×10	ND	ND

Conclusion

Results provided evidence that PPP and OPP contained bioactive compounds comprising dietary fiber, polyphenols, minerals and vitamins. They represented appreciable sources of natural origin to be used in food industry. Moreover, utilization of fruit by-products could participate in waste management by decreasing environmental pollution in a friendly manner. Overall, it could be recommended that the technology of using PPP or OPP waste should be encouraged among food industries to make economic use of local raw materials to incorporate into bakery product to provide with more functional components and more effective antioxidant and antimicrobial activity.

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