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USE OF TOMATO POMACE, MANGO SEEDS KERNEL AND POMEGRANATE PEELS POWDERS FOR THE PRODUCTION OF FUNCTIONAL BISCUITS

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ABSTRACT: This study was carried out to evaluate the chemical and phenolic contents of some by- products tomato pomace powders (TPP), mango seeds kernel powder (MSKP), and pomegranate peels powder (PPP), Also the effect of substitution of wheat flour with 2.5, 5.0, 7.5 and 10% of (TPP), (MSKP), and (PPP) on chemical, phenolic contents and sensory characteristics of biscuits was studied. Results showed that, wheat flour showed higher moisture and total carbohydrate contents. Tomato pomace powder showed high crude protein, and crude fiber contents. Mango seeds kernel powder had the highest lipids content and pomegranate peels powder had the highest ash and crude fiber contents. For total phenolic and flavonoid content, TPP contain the highest total phenolic and flavonoid content followed by PPP and finally MSKP. Also, the partial replacement of wheat flour with TPP, MSKP and PPP increased chemical composition percentage (moisture, crude protein, lipids, ash, and crude fiber), minerals content (*i.e.,* K, Ca, Mg, Na, Mn, Fe, and Zn) and dietary fiber content (*i.e.,* total, soluble and insoluble dietary fibers) of biscuit samples. However, total carbohydrates were decreased in parallel with increasing the level of substitution compared with control biscuit samples. Biscuit treatments containing TPP, MSKP and PPP had recorded the same minerals dietary fiber content. The partial replacement of wheat flour with TPP, MSKP and PPP increased total phenolic and flavonoid contents of biscuit samples compared with control sample in parallel with increasing the level of substitution. Biscuit treatments containing TPP had the highest total phenolic and flavonoid contents followed by PPP and finally MSKP treatments. The sensory evaluation characters, taste, colour, appearance, crispness, and overall acceptability, have no significant difference between the control sample and biscuit samples which substituted with 2.5, 5, and 7.5% of MSKP and TPP.

Key words: Tomato pomace, mango seeds kernel, pomegranate peels, Biscuits, total phenolic contents, sensory evaluation.

INTRODUCTION

Fruits and vegetables are essential for human nutrition, delivering a substantial proportion of vitamins, minerals, and fibers in our daily diet. Unfortunately, half the fruits and vegetables produced worldwide end up as wastes, generating environmental issues caused mainly by microbial degradation. Most wastes are generated by industrial processing, the so-called by-products. These by-products still contain many bioactive compounds post-processing, such as macronutrients (proteins and carbohydrates) and phytochemicals (polyphenols and carotenoids) **(Ain *et al.,* 2020)**.

As a result of the food insecurity associated with malnutrition and the possibility of infectious diseases, the consumer has taken great interest in the health and nutritional components of diets and has identified good strategies to tackle malnutrition and alleviate the various health disorders associated with it (**Akhtar*et al.,* 2013a, b; Sagar*et al.,* 2018**).

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Tomato wastes have no commercial value; they are a rich source of nutrients and highly biologically active compounds. The skins of tomatoes have been found to be rich source of lycopene and polyphenolic compounds than the pulp (**Toor and Savage, 2005**). Tomato seeds have been shown to contain. 20% oil of high nutritional quality, carotenoids, polyphenols, phytosterols, proteins, minerals and fibers (**Nour *et al.,* 2018**).

After the processing of mango fruits, a large amount of seeds are disposed of as waste. Fruit seeds are the most important part because they act as a storage location for nutrients. Mango seed, kernel is obtained by breaking the hard seed coat of mango. The kernel of mango seeds accounts for approximately 20 per cent of the total fruit weight **(Bisht *et al.,* 2020)**. Starch, fats and protein are the main ingredients of mango seed kernels as they contain a high amount of iron, potassium, calcium and magnesium and are a good source of natural antioxidants (**Kittiphoom, 2012; Kaur and Brar**, **2017**).

Pomegranate peel, a by-product of juice processing industries was reported to contain high phenolic compounds in addition to its properties as good source of crude fiber and inorganic residues that embrace wide health primitive features like prevention from the development of cardiovascular disorders, anti-inflammatory, hypoglycemic, apoptotic, anti-parasitic and as prebiotic (**Abdel-Rahim *et al.,* 2013**).

Supplementation of bakery products like biscuit, which are very popular among children and are a rich source of energy and protein, with tomato pomace powders, mango seeds kernel powder, and pomegranate peels powder will further help in improving the nutritional and chemical qualities of developed biscuit (**Tharshini *et al.,* 2018)**. Keeping in view that development of value added products from diverse raw ingredients is receiving the prime focus of food processing industries and researchers therefore. The present study was planned to exploit the feasibility of development of antioxidant rich biscuit from different ratios of wheat flour, tomato pomace powders, mango seeds kernel powder, and pomegranate peels powder.

MATERIALS AND METHODS

Materials

Wheat flour and by-products

Wheat flour (72% extraction rate) was obtained from the local market in Zagazig City, Egypt. Tomato pomace (peel and seeds) was obtained from Kaha Company for Preservative Foods Kaha, Kalyobia, Egypt. Mango seed kernels were obtained from Misr-Italy Company for Concentrates and Food Industries, New Damietta, Egypt. Mangoes that used in pulp production are mixture varieties of Succary, Zebda, Balady, Mabroka, and Al Owaisi. Fresh pomegranate fruit was obtained from the local marketin Zagazig, Egypt.

Baking ingredients

Fresh whole egg, dry milk, shortening, sugar, vanilla, salt, and all other materials used in baking were obtained from the local market in Zagazig, Egypt.

Chemicals

All chemicals used in this study for analysis were of analytical grade and were obtained from Al Gomhouria Chemical Company, Egypt.

Methods

Preparation of tomato pomace (peel and seeds) powder

Tomato pomace was separated manually after drying in air. Then it was dried in air circulated oven at 50˚C for 12 hr., milled to a fine powder, sieved on 110 mesh sieves, and kept in polyethylene bags and stored at - 18˚C until used.

Preparation mango seed kernels powders

Mango seeds were dried in air circulated oven and kernels were removed by manual dehiscing from the hard coat. Afterward, the kernels were chopped and then dried in air circulated oven at 40˚C for 12 hr. The dried kernels were milled to a fine powder, sieved on the 110-mesh sieve, and kept in polyethylene bags and stored at - 18˚C until used.

Preparation of pomegranate peels powder

Pomegranate peels were collected, removed, washed with water, cut into small pieces (approx. 1×1 cm) and tray dried in air circulated oven at 40˚C for 5 - 6 hr. The dried peel was coarsely powdered in a blender, passed through a 110-mesh sieve, and kept in polyethylene bags and stored at -18˚C until used.

Preparation of composite flour blends

Different composite flour samples were prepared by partially substituting wheat flour with 2.5, 5.0, 7.5, and 10% of tomatopomace (peel and seeds), mango seed kernels, and pomegranate peel powders.

Processing of biscuits

Biscuit treatments were prepared using the ingredients shown in Table 1 according to the formula reported by **Kaur and Brar (2017)**.

The processing of biscuit samples was carried out by partially replacing the 72% extraction wheat flour by four levels of tomato pomace (peel and seeds), mango seed kernels, and pomegranate peels powder 2.5, 5.0, 7.5, and 10%. The standardized recipe for the biscuits had the ingredients as 100 g flour, 20 g sugar, 50 g fat, 2 g salt, and 1.2 g baking powder. Fat was rubbed on a clean surface till it became light. Wheat flour, tomato pomace (peel and seeds), mango seed kernels, pomegranate peels flour and baking powder were sieved together and gradually added into rubbed fat. Salt and sugar were dissolved in water and made smooth dough with it. The dough was rolled out with a rolling pin and cut into the desired shape with cutter. The cuted pieces were placed over a perforated tray and baked at 150˚C for 20 minutes. After baking, biscuits were left for cooling at room temperature, wrapped in polyethylene bags, and then the bags were stored at room temperature (25±2˚C).

Analytical Methods

Chemical analyses

Chemical composition

Moisture, ash, protein, crude lipids and crude fiber contents (%) were determined according to the methods described by **AOAC (2010)**. Carbohydrate was calculated by difference as follows:

Total carbohydrate = 100 -% (ash + protein + fat + moisture)

Determination of some mineral contents

Mineral contents (Na, K, Ca, Mg, Fe, P, Mn, and Zn) were determined according to the methods of **AOAC (2010)** using atomic absorption spectrophotometry (ICAP 6500 Duo, England Multi-element certified standard solutions 100 mg/l Merk, Germany) at the Central Laboratory, Faculty of Agriculture, Zagazig University, Egypt.

Determination of dietary fibers

Total dietary fibers of samples were measured according to the method described by **AOAC (2010)**. Soluble and insoluble dietary fibers were determined according to the method described by **Prosky *et al.* (1988)**.

Determination of total phenolic content

Total phenolic compounds were determined using Folin-Ciocalteau reagent according to the method described by **Szydłowska-Czerniak *et al.* (2008)**.

Determination of total flavonoids content

Total flavonoids content was determined according to the method described by **Jia *et al.* (1998)**.

Fractionation and identification of phenolic and flavonoid compounds

A high-performance liquid chromatography system equipped with a variable wavelength detector (Agilent Technologies, Germany) 1200 series was used. Also, the high-performance liquid chromatography (HPLC) was equipped with auto-sampler, quaternary pump degasser and column compartment set at 35˚C. The analysis was performed on a C18 reverse-phase (BDS 5 µm, Labio, Czech Republic) packed stainless-steel column (4×250 mm. i.d.). To determine phenolic acids and flavonoids, samples were prepared according to the method described by **Atawodi *et al.* (2011)**.

Sensory evaluation biscuits

Biscuits samples were evaluated according to the method described by **Larmond (1977)**, using ten panelists from the Food Science Department, Faculty of Agriculture, Zagazig University. The biscuits were evaluated for their taste, colour, appearance, crispness and overall acceptability.

Table 1. Biscuit formula prepared and used in the current study

Level of substitution		Wheat flour (72% ext.) (g)	Sugar (g)	Fat (g)	Salt (g)	baking powder (g)
Control sample		100	20	50	2	1.2
Tomato pomace powder (TPP)	**2.5%**	97.5	20	50	2	1.2
	5.0%	95.0	20	50	2	1.2
	7.5%	92.5	20	50	2	1.2
	10.0%	90.0	20	50	2	1.2
Mango seed kernel powder (MSKP)	**2.5%**	97.5	20	50	2	1.2
	5.0%	95.0	20	50	2	1.2
	7.5%	92.5	20	50	2	1.2
	10.0%	90.0	20	50	2	1.2
Pomegranate peels powder (PPP)	**2.5%**	97.5	20	50	2	1.2
	5.0%	95.0	20	50	2	1.2
	7.5%	92.5	20	50	2	1.2
	10.0%	90.0	20	50	2	1.2

Statistical Analysis

Data were analyzed by Analysis of Variance using the General Linear Model (GLM) procedure according to the procedure reported by **Snedecor and Cochran (1980)**. Means were separated using Duncan's test at a degree of significance ($P \leq 0.05$). Statistical analyses were made using the producer of the SAS software system program **(SAS, 1997)**.

RESULTS AND DISCUSSION

Chemical Composition of Used Materials

Table 2 revealed that wheat flour (72% ext.) recorded the highest moisture content being 12.58%, while tomato pomace powder had the lowest moisture content being 6.65%.

Furthermore, the highest value of crude protein was recorded for TPP followed by PPP and MSKP samples being 30.69, 16.22 and 10.16%, respectively. Meanwhile, wheat flour (72% ext.) had the lowest crude protein value being 9.99%. On the other side, MSKP had the highest lipid content followed by TPP and PPP being 33.06, 8.67 and 3.51%, respectively. Meanwhile, wheat flour (72% ext.) had the lowest lipid content being 1.23%.

PPP contained the highest ash content (4.72%) followed by raw TPP (3.12%) and MSKP (2.77%). While the wheat flour (72% ext.) had the lowest ash content being 0.47%. Also, TPP contained the highest crude fiber content (8.51%) followed by PPP (7.36%) and MSKP (2.36%). Meanwhile, wheat flour (72% ext.) had the lowest crude fiber content being (0.61%).

Wheat flour (72% ext.) recorded the highest value of total carbohydrate followed by PPP and MSKP being 87.70, 68.19 and 51.65%, respectively. While TPP had the lowest total carbohydrate being 49.01%. These results are in agreement with **Sakr *et al.* (2012), El-badrawy and Sello (2016) and Abd-Elaziz (2018).**

Minerals Content of Used Materials

Results presented in Table 2, show the mineral content of wheat flour (72% ext.), TPP, MSKP and PPP. PPP had contained high content of Magnesium (Mg), Sodium (Na), and Iron (Fe) compared with TPP, MSKP, and wheat flour. It was recorded 40.58, 130.48, and 4.30 mg/100g, respectively.

Table 2. Chemical composition, minerals content, dietary fiber and antioxidant properties of wheat flour, tomato pomace powder, mango seeds kernel powder, and pomegranate peels powder

Component	Wheat flour (WF)	Tomato pomace powder (TPP)	Mango seeds kernel powder (MSKP)	Pomegranate peels powder (PPP)
Chemical composition (g/100gon a dry weight basis)				
Moisture	12.58	6.65	7.31	9.06
Crude protein	9.99	30.69	10.16	16.22
Crude fat	1.23	8.67	33.06	3.51
Ash	0.47	3.12	2.77	4.72
Crude fiber	0.61	8.51	2.36	7.36
Carbohydrate	87.70	49.01	51.65	68.19
Minerals content (mg/100gon a dry weight basis)				
Ca	35.69	37.65	115.16	41.61
Zn	0.18	1.67	1.35	1.57
Fe	0.87	3.08	1.27	4.30
Mg	15.76	38.08	20.32	40.58
K	27.33	56.50	280.71	205.38
Na	35.88	79.45	60.32	130.48
Mn	1.46	21.96	2.03	18.16
Dietary fiber(g/100g on a dry weight basis)				
Total dietary fiber	3.42	36.28	25.17	54.39
Soluble dietary fiber	1.29	4.75	7.45	13.63
Insoluble dietary fiber	2.13	31.53	17.72	40.76
Antioxidant activity				
Total phenolic content (mg /g)TP	34.05	848.52	247.18	386.47
Total flavonoids content (mg/g)TF	25.30	437.97	134.15	252.26

Also, MSKP contained higher amount of potassium and calcium being 280.71, 115.16, respectively compared to TPP which recorded 56.50, 37.65 mg/100g for Potassium (K), Calcium (Ca). Additionally, the highest content of Mn and Zn were observed in TPP with a concentration of 21.96, 1.67 mg/100g, respectively.

Wheat flour (72% ext.) had the mean lowest mineral content being 27.33, 35.69, 15.76, 35.88, 1.46, 0.87, and 0.18 mg/100g, for K, Ca, Mg, Na, Mn, Fe, and Zn, respectively. Such results are in line with those obtained by **Khedr *et al.* (2016), Romelle *et al.* (2016), Nour *et al.* (2018) and Abd-Elaziz (2018).**

Total, Soluble, and Insoluble Dietary Fiber of Used Materials

Table 2 shows that PPP and TPP contain the highest percentage of total dietary fiber (TDF), which amounted to 54.39 and 36.28%, respectively. These results are following those obtained by **Thannoun and Younis (2013); Mosa and Kalil (2015) and Khedr *et al.* (2016)**.

Wheat flour (72% ext.) contained 3.42% TDF, 1.29% SDF, and 2.13% IDF. **Gill and Johnson (2002)** reported that, wheat flour (72% ext.) contained 4.19% TDF, 2.28% SDF, and 1.91% IDF (on dry weight basis).

Total Phenolic and Flavonoid Compounds of Used Materials

According to the results presented in Table 2, TPP contain higher Total phenolic (TP) and Total flavonoid (TF) with 848.52 (mg of Gallic acid/g) and 437.97 (mg of quercetin/g), respectively. These results agree with that previously reported by **Szabo *et al.* (2019)**, followed by PPP with 386.47 (mg of Gallic acid/g) and 252.26 (mg of quercetin/g), respectively. These results agree with that previously reported **(Ali *et al.*, 2014),** MSKP contained 247.18 mg of Gallic acid/g and 134.15 mg of quercetin/g, respectively. These results are in agreement with that previously reported (**Abdalla *et al.*, 2007; Ribeiro and Schieber, 2010; Sogi *et al.*, 2013; Dorta *et al.*, 2014; Abdel-Aty *et al.*, 2018**). WF contained 34.05 mg of Gallic acid/g and 25.30 mg of quercetin/g, respectively. These results are similar with that previously reported by **Yu and Beta (2015).**

Identification of Phenolic Compounds Content of Used Materials

According to the results presented in Table 3, the phenolic compounds in wheat flour (WF) ranged from 1.00 to 199.64 µg/g dry matter. The predominant compound in WF was Naringenin (199.64 µg/g). These results are similar to those reported by **Yu and Beta (2015)**. They indicated that the ethanol extraction of WF had high content of Naringenin. The phenolic compounds in TPP ranged from 3.22 to 296.48 µg/g dry matter. The predominant compound in TPP was Kaempferol (296.48 µg/g). These results are similar to those reported by **Szabo *et al.* (2019),** who indicated that the ethanol extraction of TPP had high content of Kaempferol.

The phenolic compounds in MSKP ranged from 33.67 to 7595.92 µg/g dry matter. The predominant compound in MSKP was Naringenin (7595.92 µg/g). These results are agreed with to those reported by **Abdel-Aty *et al.* (2018)**, who indicated that the ethanol extraction of MSKP had high content of Naringenin.

The phenolic compounds in PPP ranged from 10.42 to 8671.04 µg/g dry matter. The predominant compound in PPP was Catechin (8671.04 µg/g). These results are similar to those reported by **Ali *et al.* (2014),** who indicated that the ethanol extraction of PPP had high content of Catechin.

Properties of Biscuit

Chemical composition of produced biscuit

Results presented in Table 4, show that the partial replacement of wheat flour with TPP, MSKP and PPP increased chemical composition (%) (moisture, crude protein, lipids, ash, and crude fiber) of biscuit samples in parallel with increasing the level of substitution compared with control biscuit sample, while total carbohydrates were decreased in parallel with increasing the level of substitution.

Biscuit treatments containing TPP, MSKP and PPP had also recorded the same trend of chemical composition. Results are in line with those obtained by **Ifesan (2017) and Kaur and Brar (2017)**.

Mineral content of produced biscuit

Results presented in Table 5 show that the partial replacement of wheat flour with TPP, MSKP and PPP increased minerals content (%) (*i.e.,* K, Ca, Mg, Na, Mn, Fe, and Zn), of biscuit samples compared with control biscuit sample in parallel with increasing the level of substitution. Biscuit treatments containing TPP, MSKP and PPP have also recorded the same trend of minerals content. These results are in line with those obtained by **Srivastava *et al.* (2014), Isik and Topkaya (2016) and Kaur and Brar (2017).**

Total, soluble and insoluble dietary fiber of produced biscuit

Results presented in Table 6 reveal that the partial replacement of wheat flour with TPP, MSKP and PPP increased dietary fiber (%) (*i.e.* total, soluble and insoluble dietary fiber) of biscuit samples compared with control biscuit sample in parallel with increasing the level of substitution. Biscuit treatments containing TPP, MSKP and PPP had also recorded the same trend of dietary fiber**.** Results are in line with those obtained by **Srivastava *et al.* (2014), Isik and Topkaya (2016) and Kaur and Brar (2017).**

Total phenolic and flavonoid compounds of produced biscuit

Results presented in Table 7 show that the partial replacement of wheat flour with TPP,

Table 3. Identification of phenolic compounds content of wheat flour, tomato pomace powder, mango seeds kernel powder, and pomegranate peels powder by HPLC (µg/g dry matter)

Phenolic compound	Materials			
	Wheat flour (72% ext.) (WF)	Tomato pomace powder (TPP)	Mango seeds kernel powder (MSKP)	Pomegranate peels powder (PPP)
Gallic acid	15.22	42.03	0.00	1248.00
Chlorogenic acid	0.00	0.00	426.76	0.00
Catechin	3.00	41.84	0.00	8671.04
Methyl gallate	0.00	4.75	57.72	14.80
Coffeic acid	1.30	10.88	276.89	62.87
Syringic acid	0.00	0.00	406.72	0.00
Pyro catechol	0.00	46.47	0.00	0.00
Rutin	0.00	0.00	600.10	0.00
Ellagic acid	23.00	72.60	313.73	1698.35
Coumaric acid	6.00	43.03	0.00	66.10
Vanillin	7.54	3.22	2886.36	10.42
Ferulic acid	2.00	12.70	802.94	184.89
Naringenin	199.64	36.71	7595.92	59.81
Taxifolin	0.00	25.46	33.76	0.00
Cinnamic acid	1.00	17.00	0.00	58.00
Kaempferol	0.00	296.48	0.00	0.00

Table 4. Proximate chemical composition of produced biscuit samples (% on dry matter basis)

Biscuit sample	Substitution level (%)	Chemical composition (%)					
		Moisture	Crude protein	Lipids	Ash	Crude fiber	** Total carbohyd rates
*Control sample		3.69	19.19	30.10	0.89	3.60	46.22
Tomato pomace powder (TPP)	**2.5**	4.51	19.71	30.29	0.96	3.80	45.24
	5.0	5.30	20.23	30.47	1.02	4.00	44.28
	7.5	6.14	20.75	30.66	1.09	4.19	43.31
	10.0	6.97	21.27	30.84	1.15	4.39	42.35
Mango seeds kernel powder (MSKP)	**2.5**	4.23	19.19	30.89	0.95	3.64	45.33
	5.0	4.78	19.20	31.70	1.00	3.69	44.41
	7.5	5.32	19.20	32.48	1.06	3.73	43.53
	10.0	5.86	19.21	33.26	1.12	3.78	42.63
Pomegranate peels powder (PPP)	**2.5**	4.96	19.35	30.16	1.00	3.77	45.72
	5.0	6.24	19.51	30.21	1.10	3.94	45.24
	7.5	7.50	19.67	30.27	1.21	4.11	44.74
	10.0	8.78	19.83	30.33	1.34	4.28	44.22

* 100% wheat flour (72% extraction rate). ** Calculated by difference.

Table 5. Minerals content of produced biscuit samples (mg/100g on dry matter basis)

Biscuit sample	Substitution level (%)	Mineral content						
		K	Ca	Mg	Na	Mn	Fe	Zn
*Control sample		16.36	24.44	22.50	38.87	0.53	1.43	0.57
Tomato pomace powder (TPP)	2.5	17.09	24.49	23.06	39.96	1.04	1.49	0.61
	5.0	17.82	24.53	23.62	41.05	1.55	1.54	0.65
	7.5	18.55	24.64	24.17	42.14	2.07	1.60	0.68
	10.0	19.28	24.87	24.73	43.23	2.58	1.65	0.72
Mango seeds kernel powder (MSKP)	2.5	22.70	26.43	22.61	39.48	0.54	1.44	0.60
	5.0	29.03	28.41	22.73	40.09	0.56	1.45	0.63
	7.5	35.37	30.29	22.84	40.70	0.57	1.46	0.66
	10.0	41.69	32.38	22.96	41.31	0.59	1.47	0.69
Pomegranate peels powder (PPP)	2.5	20.81	24.59	23.12	41.24	0.95	1.52	0.61
	5.0	25.26	24.74	23.74	43.60	1.36	1.60	0.64
	7.5	29.72	24.88	24.36	45.97	1.78	1.69	0.67
	10.0	34.17	25.03	24.98	48.33	2.20	1.77	0.72

Table 6. Total, soluble and insoluble dietary fiber of produced biscuit samples (g/100g dry matter)

Biscuit sample	Substitution level (%)	Dietary fiber		
		Total dietary fiber	Soluble dietary fiber	Insoluble dietary fiber
*Control sample		1.84	0.70	1.14
Tomato pomace powder (TPP)	2.5	2.66	0.79	1.87
	5.0	3.48	0.87	2.61
	7.5	4.31	0.96	3.35
	10.0	5.14	1.05	4.09
Mango seeds kernel powder (MSKP)	2.5	2.38	0.85	1.53
	5.0	2.93	1.01	1.92
	7.5	3.47	1.16	2.31
	10.0	4.02	1.32	2.70
Pomegranate peels powder (PPP)	2.5	3.12	1.00	2.12
	5.0	4.39	1.32	3.07
	7.5	5.66	1.63	4.03
	10.0	6.94	1.94	5.00

* 100% wheat flour (72% extraction rate).

Table 7. Total phenolic and flavonoid compounds of biscuit prepared by substituted of wheat flour with tomato pomace powder, mango seeds kernel powder, and pomegranate peels powder

Biscuit sample	Substitution level (%)	Total phenolic	Total flavonoid
*Control sample		36.52	28.45
	2.5	56.88	38.76
Tomato pomace powder	5.0	77.25	49.08
(TPP)	7.5	96.84	60.02
	10.0	117.96	68.45
	2.5	41.85	31.17
Mango seeds kernel powder	5.0	47.18	33.89
(MSKP)	7.5	52.51	36.62
	10.0	57.84	39.33
	2.5	45.33	34.12
Pomegranate peels powder	5.0	54.14	39.80
(PPP)	7.5	62.95	45.47
	10.0	71.78	51.13

* 100% wheat flour (72% extraction rate).

MSKP and PPP increased total phenolic and flavonoid content of biscuit samples compared with control biscuit sample in parallel with increasing the level of substitution.

Biscuit treatments containing TPP had the highest total phenolic and flavonoid contents followed by PPP and finally MSKP. These results are in line with those obtained by **Srivastava *et al.* (2014), Isik and Topkaya (2016) and Kaur and Brar (2017)**.

Sensory Evaluation of Produced Biscuit

Table 8 revealed the substitution with TPP, and MSKP. All the sensory evaluation characters; taste, colour, appearance, crispness, and overall acceptability, had significant difference between the control sample and biscuit samples which substituted with 2.5, 5, and 7.5% of MSKP and TPP. These results are in agreement with **Sharoba *et al.* (2013). Srivastava *et al.* (2014), Isik and Topkaya (2016) and Kaur and Brar (2017)**.

Conclusion

From this study, it can be concluded that a biscuit with acceptable sensory properties can be produced from wheat flour, tomato pomace powder, and mango seed powder blends. Hence, it is recommended that value-added products be developed from wheat flour, tomato pomace and mango seed kernel powders, which are rich in protein, minerals, nutritional fibers and phenolic compounds. The development and use of wheat flour, tomato seeds, and mango seed kernel powder products will increase the alternative uses of grains and pulses, and will enhance the use of peel which is usually discarded. Wheat flour could be replaced by 2.5 to 7.0% of tomato pomace and mango seed kernel powders with good properties and high nutritional value.

Table 8. Sensory evaluation of biscuit samples

Biscuit sample	Substitution level (%)	Taste (10)	Color (10)	Appearance (10)	Crispness (10)	Overall acceptability (10)
****Control sample**		9.70^{A}	9.60^{A}	9.60^{A}	9.60^{A}	9.80^{A}
Tomato pomace powder (TPP)	**2.5**	9.40^{AB}	8.40^{BC}	8.40^{BCDE}	8.30^{BC}	8.75^{BCD}
	5.0	9.20^{AB}	8.20^{BCDE}	8.35^{BCDE}	8.25^{BC}	8.60^{BCD}
	7.5	9.20^{AB}	7.30^{DEF}	7.60^{EF}	7.80^{CD}	7.80^{DE}
	10.0	8.20^{CD}	7.20^{EF}	7.50^{EF}	7.60^{CD}	7.20^{EF}
Mango seeds kernel powder (MSKP)	**2.5**	8.65^{BCD}	9.50^{A}	9.20^{AB}	9.20^{A}	9.25^{AB}
	5.0	8.50^{BCD}	8.35^{BCD}	8.80^{ABCD}	9.00^{AB}	9.20^{AB}
	7.5	7.70^{DE}	8.20^{BCDE}	8.30^{BCDE}	8.30^{BC}	8.20^{CD}
	10.0	7.50^{EF}	7.90^{CDEF}	7.90^{DEF}	8.10^{BC}	8.20^{CD}
Pomegranate peels powder (PPP)	**2.5**	9.20^{AB}	9.00^{AB}	9.00^{ABC}	9.40^{A}	8.90^{ABC}
	5.0	8.40^{BCD}	8.60^{ABC}	8.40^{BCDE}	8.30^{BC}	8.40^{BCD}
	7.5	7.40^{EF}	7.80^{CDEF}	8.10^{CDEF}	7.80^{CD}	8.00^{CDE}
	10.0	7.00^{F}	6.90^{F}	7.20^{F}	7.00^{D}	6.80^{F}

* Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$).

** 100% wheat flour (72% extraction rate).

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استخدام مساحيق تفل الطماطم، بذور المانجو و قشور الرمان لإنتاج البسكويت الوظيفى

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أجريت هذه الدراسة لتقييم التركيب الكيميائي ومحتوى الفينولات الكلية لبعض النواتج الثانوية لمنتجات مسحوق تفل الطماطم (TPP)، ومسحوق بذور المانجو (MSKP)، ومسحوق قشور الرمان (PPP)، وكذلك تمت دراسة تأثير استبدال دقيق القمح بـ ٢.٥، ٥.٠ ، ٧.٥ و١٠% من (TPP) و(MSKP) و (PPP) على التركيب الكيميائي ومحتوى الفينولات الكلية والخصائص الحسية للبسكويت، وأظهرت النتائج أن دقيق القمح أظهر أعلى محتوى من الرطوبة وإجمالي الكربوهيدرات الكلية، وأظهر مسحوق تفل الطماطم أعلى محتوى من البروتين الخام، والألياف الخام، وأعطى مسحوق بذور المانجو أعلى محتوى فى نسبة الدهن وأظهر مسحوق قشور الرمان أعلى محتوى من نسبة الرماد والألياف الخام، بالنسبة لمحتوى الفينولات والفلافونويد، أظهر مسحوق تفل الطماطم أعلى محتوى لإجمالي الفينولات والفلافونويد الكلية يليه مسحوق قشور الرمان وأخيرًا مسحوق بذور المانجو، أيضًا ، أدى الاستبدال الجزئي لدقيق القمح بـ مساحيق تفل الطماطم (TPP)، بذور المانجو (MSKP)، و قشور الرمان (PPP) إلى زيادة نسب التركيب الكيميائي (الرطوبة والبروتين الخام والدهون والرماد والألياف الخام)، ومحتوى المعادن (مثل K، Ca، Mg، Na، Mn، Fe، و Zn) ومحتوى الألياف الغذائية (الألياف الغذائية الكلية، القابلة للذوبان وغير القابلة للذوبان) لعينات البسكويت، في حين انخفض إجمالي الكربوهيدرات بالتوازي مع زيادة مستوى الاستبدال مقارنة مع عينات بسكويت المقارنة، كما سجلت معاملات البسكويت التي تحتوي على مساحيق تفل الطماطم (TPP)، بذور المانجو (MSKP)، وقشور الرمان (PPP) نفس الاتجاه فى التركيب الكيميائي، الاملاح المعدنية ومحتوى الالياف الكلية، كما أدى الاستبدال الجزئي لدقيق القمح بـ مساحيق تفل الطماطم (TPP)، بذور المانجو (MSKP)، و قشور الرمان (PPP) إلى زيادة إجمالي محتوى الفينولات والفلافونويد لعينات البسكويت مقارنة بعينة المقارنة بالتوازي مع زيادة مستوى الاستبدال، وكان لمعاملات البسكويت المحتوية على مسحوق تفل الطماطم أعلى محتوى لإجمالي الفينول والفلافونويد تليه العينات المحتوية على مسحوق قشور الرمان وأخيرًا، المعاملات المحتوية على مسحوق بذور المانجو ومن حيث خواص التقييم الحسية، التذوق، اللون، المظهر، الهشاشة، والقبول العام ، وجد انه ليس هناك فرقًا كبيرًا بين عينة المقارنة وعينات البسكويت التي تم استبدالها بـ ٢.٥ ، ٥ و ٧.٥% من مساحيق تفل الطماطم (TPP)، بذور المانجو (MSKP).

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