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Physicochemical and Sensory Properties of Snacks Supplemented with Pomegranate Pomace and Mushroom Stalk Powders

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Abstract: The physicochemical and sensory properties of snacks supplemented with pomegranate pomace and mushroom stalk powders was studied. Snacks recipes were prepared; using 100% wheat flour, 10 and 20 % replacement levels of wheat flour (WF) by pomegranate pomace powder (PPP) and 10 and 20 % replacement levels of wheat flour (WF) by mushroom stalk powder (MSP). Supplementation of snacks with pomegranate pomace powder (PPP) at different concentrations increased ash , fiber , potassium and phenolic contents of fortified snacks and these increments were proportional to the fortification ratio , while Supplementation of snacks with mushroom stalk powder (MSP) at different concentrations increased moisture, protein, ash , fiber, calcium ,potassium and phenolic contents of fortified snacks and these increments were proportional to the fortification ratio. Also, the snacks produced from replacement levels of wheat flour by mushroom stalk powder at both concentrations gave the highest scores of sensory properties than that control and pomegranate pomace fortified snacks. All snacks treatments gained acceptable sensory properties. From the results it can be concluded that replacing wheat flour with mushroom stalk and pomegranate seed powders in the manufacture of snacks up to 20%, this substitution increased the phenolic and dietary fiber contents, organoleptic properties and the nutritional value of the product.
Keywords: Snacks, Pomegranate pomace, Mushroom stalk, Phenolic content, Sensory properties.

1 Introduction

The popularity of bakery products has contributed to increased demand for ready-to-eat, convenience food products, such as bread, biscuits, snacks and other pastry products **(David, 2006).**

A snack is a convenient ready-to-eat which consumed by young people in many countries. The development of food products with the use of food additives has increased and has attracted great interest from researchers; especially in the production of snacks (**Forsido *et al*., 2019).**
The general trend is increasing towards the use of by-products such as some agricultural crop residues as by-products in food processing around the world (**Abd Rabo *et al.*, 2019**).
During the industrial production of pomegranate juice, significant quantities of pomace are produced (composed mainly of non-edible rind، and residual arils pulp, and carpelar membranes), and they account for about 50% on average fresh weight. In recent years, attention has been paid to the inedible portions of pomegranate (**Hasnaoui *et al*. 2014**), mainly due to their high antioxidant content. In this way, the reuse of pomegranate pomace, obtained from the juice industry to take advantage of the vast amount of beneficial compounds, can be of significance in products that require hydration, viscosity development, antibacterial agents and freshness preservation, such as baked foods or cooked meat products (**Gullon *et al*., 2016; Akhtar *et al*., 2015**). Moreover, pomegranate pomace can be used as a washing agent due to its antimicrobial properties against *Listeria monocytogenes* (**Kang and Song 2017).**

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The stalk and other parts of the mushroom are removed during harvesting which application as functional food ingredients in food products, as they are a rich source of dietary fiber and several other bioactive compounds like minerals, vitamins, and polyphenols which exhibit good antioxidant, anti-inflammatory, immunomodulatory, anti-cancer and cholesterol-lowering activities **(Pateiro *et al*,2018 and Madane *et al* ,2020**). These dietary fibers, in combination with phenolic compounds, form antioxidant dietary fibers (ADFs) (**Das *et al*., 2020)** which can be used as dietary supplements to improve gastrointestinal health, or as technical ingredients to inhibit lipid oxidation in foods, thereby extending their shelf-life (**Madane *et al* .,2020).**The present study was carried out to evaluate the effect of pomegranate pomace and mushroom stalk powders on the physicochemical and sensory properties of the snacks.

2 Materials and Methods

Materials

Wheat variety (*Triticum sativum*) cultivar, wheat grain was milled for 72% extraction using Buhler laboratory pneumatic flour mill. Pomegranate and mushroom were purchased from local market. Pomegranate pomace was obtained after extraction of juice, The mushroom stalk were collected, Pomegranate pomace and mushroom stalk were washed and dried in thermostatically controlled oven with air fan at 40-45°C for 48 hrs., then milled using a laboratory disc to pass through a 40 mesh/inch sieve, stored at 3-4°C until used for technological studies.1, 1-diphenyl-2-picrylhydrazyl (DPPH), Gallic acid and other chemicals and reagents were purchased form Sigma-Aldrich (MO,IL USA).

Methods

Preparation of Snacks

The flour blends were prepared according to the ratio presented in Table (1). Different blends were mixed at the rate of 100g blended flour with 1.5 g active dry yeast, sodium chloride (1.5 g), sugar (1g), and vanilla (1g). The dough was left to ferment for 1 h for 30ºC at 85% relative humidity. The dough was divided to pieces each weighted 20gm. The pieces were arranged on trays and were left to ferment for a further 30 min at the same temperature and relative humidity. The pieces of fermented dough and left again for 15 min at the same temperature and relative humidity then were baked at 230 ºC for 10 min. snacks were allowed to cool on racks for about 1 h before evaluation.

Table 1: The flour blends wheat, pomegranate pomace and mushroom stalk powder for snacks making**.**

Sample	Blends (%)		
	Wheat flour (WF)	**Pomegranate pomace powder (PPP)**	**Mushroom stalk powders (MSP)**
C	100	0	0
T1	90	10	0
T2	80	20	0
T3	90	0	10
T4	80	0	20

Chemical Analysis

Moisture, protein, fat, crude fibers, ash and minerals contents of snacks samples were measured according to the **AOAC (2016).** Total carbohydrate was calculated by difference. Total calories were calculated as mentioned by **Kerolles (1986)** according to the following equation Total calories = 4 (protein + Carbohydrates) + 9 (fat).

Determination of total phenolic content:

The total phenolic content (TPC) of the extract was determined by Folin-Ciocalteu assay using Gallic acid as the standard according to **Kaur and Kapoor (2002)** .The total phenolic content was expressed as gallic acid equivalents (mg GAE/100g dry weight basis) through the calibration curve of Gallic acid.

Radical scavenging activity (Scavenging DPPH)

The antioxidant activity was evaluated by the DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay according to **Brand Williams *et al*,(1995).** The scavenging activity percentage (AOA %) was determined according to **Mensor *et al*,(2001)** as follows:

$$AOA(\%) = 1- Abs_{sample} - Abs_{blank} / Abs_{control} \times 100 \quad (1)$$

Sensory Properties

Snack samples were evaluated for color (20), flavor (20), taste (20), crispiness (20), appearance (20) and overall acceptability (100) according to the method described in **AACC (2000).**

Statistical analysis

Data were statically analyzed and the differences between the means of the treatments were considered significant when they were more than the least significant differences (L.S.D) at the 5% level by using computer program of Statistic version 9 (**Analytical Software, 2008**).

3 Results and Discussion

Chemical composition of pomegranate pomace and mushroom stalk powder

The proximate macro nutrients contents of wheat flour, pomegranate pomace and mushroom stalk powder are illustrated in Table (2) .The results showed that there is a difference between for each macro nutrients contents. Moisture, protein, fat, ash and fiber contents of wheat flour (WF) were (11.66, 12.54, 1.44, 0.58 and 0.92 g/100g respectively. These results are in agreement with the data obtained by **Sakr *et al*. (2012).**Moisture, protein, fat, ash and fiber contents of pomegranate pomace powder (PPP) were (8.40, 8.60, 1.80, 8.90 and 31.70 g/100g respectively. These results are in agreement with the data obtained by **Cano-Lamadrid *et al*, (2018)**.Moisture, protein, fat, ash and fiber contents of mushroom stalk powder (MSP) were (12.26,13.12, 1.40, 9.20 and 33.14 g/100g respectively. These results are in agreement with the data obtained by **Abu El-Maaty, *et al*, (2016) and Banerjee *et al* ., (2020).**

Table (2) shows the average of calcium, phosphor and potassium contents of wheat flour, pomegranate pomace and mushroom stalk powder. Whereas MSP contained the highest amount of potassium and calcium than WF and PPP. While WF contained the highest amount of phosphor
Table (2), also, revealed that, the TPC of WF, PPP and MSP extracts were 330.20, ٥90.30 and 410.80 mg/100g, respectively. While the RSA (%) of WF, PPP and MSP extracts were 78.60, 90.60 and 86.40%, respectively. These results agree with that previously reported **Yu and Beta, (2015)** for WF, **Cano-Lamadrid *et al*, (2018)** for pomegranate pomace and **Abu El-Maaty, *et al*, (2016) and Banerjee *et al* ., (2020)** for mushroom stalk.

Table 2: Chemical composition, minerals, Total phenolic, flavonoid contents and radical scavenging activity of pomegranate pomace and mushroom stalk powder.

Chemical composition	Wheat flour	Pomegranate pomace powder	Mushroom stalk powder
Moisture (%)	11.66	8.40	12.26
Total protein (%)	12.54	8.60	13.12
Fat (%)	1.44	1.80	1.40
Ash (%)	0.58	8.90	9.20
Fiber (%)	0.92	31.70	33.14
Potassium mg /100g	27.33	120.24	350.66
Calcium mg /100g	35.69	5.40	180.31
Phosphorus mg /100g	72.40	1.84	30.68
Total phenolic content(mg/100g)	330.20	٥٩٠.٣٠	410.80
Radical scavenging activity (%)	78.60	90.60	٨٦.٤٠

Chemical composition of different types of fortified snacks:

Chemical compositions of fortified snacks samples are shown in Tables 3. MSP snacks had the lowest moisture content and it was significantly ($P \leq 0.05$) compared with control and PPP snacks treatments. PPP snacks treatments had the highest moisture content compared with MSP snacks treatments. PPP snacks had the lowest protein content. The total protein of snacks containing PPP at both concentrations slightly decreased by increasing the percentage added, MSP snacks treatments had the highest protein contents compared with control and PPP snacks treatments.

Supplementation of snacks with PPP and MSP powders at both concentrations did not effect on fat contents, with respect to ash contents, supplementation of ash contents with PPP and MSP at both concentrations increased gradually ash contents by increasing the percentage added, MSP snacks treatments had the highest ash contents compared with control and PPP snacks treatments.

Total fiber content of snacks treatments increased by adding PPP and MSP at both concentrations and these increments were proportional to the fortification ratio, MSP snacks treatments had the highest fiber contents compared with control and PPP snacks treatments.

Carbohydrate content of snacks treatments decreased by adding PPP and MSP at both concentrations and these decrements were proportional to the fortification ratio, MSP snacks treatments had the lowest carbohydrate contents compared with control and PPP snacks treatments.

Supplementation of snacks with PPP and MSP powders at both concentrations reduced the total calories of supplemented snacks and this reducing was proportional to the fortification ratio. MSP snacks treatments had the lowest total calories compared with control and PPP snacks treatments. These results are in agreement with the data obtained by **Pastuszka *et al*. (2012) , El Shebini, *et al*, (2014),** and **Dewidarand EL ghandour, (2020),** who studied chemical, rheological and sensory properties of wheat-oat flour composite snacks.

Table 3: Chemical composition of produced snacks.

Snacks treatments	Moisture %	Protein %	Fat %	Ash %	Fiber %	Carbohydrates%	Calories
C	6.14^{B}	11.94^{B}	1.52^{BC}	0.74^{D}	1.04^{E}	78.62^{A}	375.92^{A}
T1	5.88^{D}	11.56^{C}	1.56^{Ab}	1.42^{C}	3.12^{D}	76.44^{B}	366.04^{B}
T2	5.52^{C}	11.14^{D}	1.60^{A}	2.10^{A}	5.90^{B}	73.74^{D}	353.92^{D}
T3	6.20^{B}	12.00^{B}	1.50^{C}	1.48^{B}	3.46^{C}	75.36^{C}	362.94^{C}
T4	6.28^{A}	12.08^{A}	1.52^{BC}	2.14^{A}	6.18^{A}	71.80^{E}	349.20^{E}
LSD	٠.٠٦١٧	0.0617	0.0654	٠.٠٥٠٤	0.0617	٠.٠٦١٧	٠.٠٥٠٤

Means followed by different capital letters in the same column are significantly different ($p \leq 0.05$).
L.S.D: Least significant difference

C: Snacks manufacture with wheat flour (72% ext.).
T1: Snacks manufacture with wheat and 10% pomegranate pomace powder.
T2: Snacks manufacture with wheat and 20% pomegranate pomace powder.
T3: Snacks manufacture with wheat and 10% mushroom stalk powder.
T4: Snacks manufacture with wheat and 20% mushroom stalk powder.

Minerals content of produced cake:

Results presented in Table 4 showed that the partial replacement of wheat flour with PPP and MSP increased potassium content of snacks samples compared with control snacks sample in parallel with increasing the level of substitution. Partial replacement of wheat flour with MSP increased calcium content of snacks samples compared with control and PPP snacks samples. Snacks treatments containing PPP and MSP recorded the lowest of phosphorus content compared with control snacks sample. Such data are in line with those obtained by **Saeidi *et al* (2018) and Levent *et al* ,(2021).**

Table 4: Minerals content of produced snacks.

Snacks treatments	Calcium (Ca)	Phosphor (P)	Potassium (K)
C	18.22^{BC}	60.30^{A}	56.70^{E}
T1	10.80^{BC}	54.60^{C}	65.20^{D}
T2	6.40^{C}	46.90^{E}	74.41^{C}
T3	30.76^{AB}	57.40^{B}	88.50^{B}
T4	43.50^{A}	52.80^{D}	106.30^{A}
LSD	21.822	0.0317	0.0136

Means followed by different small letters in the same column are significantly different ($p \leq 0.05$).
L.S.D: Least significant difference **.**

C: Snacks manufacture with wheat flour (72% ext.).
T1: Snacks manufacture with wheat and 10% pomegranate pomace powder.
T2: Snacks manufacture with wheat and 20% pomegranate pomace powder.
T3: Snacks manufacture with wheat and 10% mushroom stalk powder.
T4: Snacks manufacture with wheat and 20% mushroom stalk powder.

Total phenolic content and radical scavenging activity of produced snacks:

Results presented in Table 5 showed that the partial replacement of wheat flour with PPP and MSP increased total phenolic content and radical scavenging activity of snacks samples compared with control snacks sample in parallel with increasing the level of substitution.

Snacks treatments containing PPP had the highest total phenolic content and radical scavenging activity followed by MSP and finally control sample this may be due to a high phenolic content of PPP(**Cano-Lamadrid *et al*., 2018**) and MSP(**Banerjee et al .,2020**) . Such data are in line with those obtained by **Abu El-Maaty *et al* (2016)** and **Sheikh *et al* (2010)** , who found that addition of MSP to pan bread and cake increased the phenolic content and radical scavenging activity of product . **Bourekoua *et al*, (2018)** who found that addition of pomegranate seed powder to bread increased the phenolic content and radical scavenging activity of product.

Table 5: Total phenolic content and radical scavenging activity of produced snacks.

Snacks treatments	Total phenolic content(mg/100g)	Radical scavenging activity (%)
C	72.34^{E}	32.50^{E}
T1	96.54^{B}	34.80^{B}
T2	120.60^{A}	39.60^{A}
T3	83.46^{D}	32.90^{D}
T4	94.30^{C}	33.50^{C}
LSD	٠.٠٢٨٢	0.3449

Means followed by different small letters in the same column are significantly different ($p \leq 0.05$).
L.S.D: Least significant difference

C: Snacks manufacture with wheat flour (72% ext.).
T1: Snacks manufacture with wheat and 10% pomegranate pomace powder.
T2: Snacks manufacture with wheat and 20% pomegranate pomace powder.
T3: Snacks manufacture with wheat and 10% mushroom stalk powder.
T4: Snacks manufacture with wheat and 20% mushroom stalk powder.

Sensory Attributes

Data presented in Table 6 show the sensory evaluation of snacks as a function of replaced WF with PPP and MSP. Regarding color and appearance, it could be noticed that no significant differences between snacks from WF (control) and snacks from mixtures of WF with MSP (T1 and T2) while snacks from mixtures of WF with PPP recorded low values for color and appearance compared with control and MSP snacks. Partial replacement of wheat flour with PPP and MSP increased the taste, flavor, crispiness, and overall acceptability scores and these increments were proportional to the f replacement ratio .MSP snacks had the highest scores for sensory attributes flowed by control snacks and finally PPP snacks .the results obtained are agree with **Süfer *et al*, (2016),** who found that replaced wheat flour with mushrooms powder in snacks gave acceptable Sensory attributes. **Saeidi *et al* (2018);** and **Bourekoua et *al*. (2018),** who found that replaced wheat flour with pomegranate seed powder in bakery products cased enhancement in taste, appearance and overall acceptability.

Table 6: Sensory evaluation of produced snacks.

Snacks treatments	Color (20)	Flavor (20)	Taste (20)	Crispness (20)	Appearance (20)	Overall acceptability (100)
C	18.6^{A}	17.8^{C}	18.3^{B}	17.50^{B}	17.80^{A}	90.00^{A}
T1	16.3^{C}	18.5^{ABC}	18.8^{AB}	17.90^{AB}	16.40^{BC}	87.90^{A}
T2	15.8^{C}	19.2^{A}	19.1^{A}	18.30^{A}	16.00^{C}	88.40^{A}
T3	18.2^{AB}	18.2^{BC}	18.6^{AB}	17.80^{AB}	17.50^{A}	90.30^{A}
T4	17.9^{B}	18.6^{AB}	18.9^{AB}	18.00^{AB}	17.20^{AB}	90.60^{A}
LSD	0.5771	0.7288	0.6907	0.7964	1.0554	2.7401

Means followed by different small letters in the same column are significantly different ($p \leq 0.05$).
L.S.D: Least significant difference**.**

4 Conclusions

Mushroom stalk and pomegranate pomace powders can be used in snacks manufacture; results showed that replacing wheat flour with mushroom stalk and pomegranate pomace powders in the manufacture of snacks up to 20% increased the phenolic and dietary fiber contents, organoleptic properties and the nutritional value of the product.

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