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Bioactive compounds and antioxidant activity of some fruit and vegetable wastes

Bekheet, M.A[a]; Riyad, Y.M[a]; Hosny, M.H[b] and Mayada, M.A[b]*

[a]*Department of Food Science, Faculty of Agriculture, Cairo University, Egypt*

[b]*Department of Bread and Pasta Research, Food Technology Research Institute-Agriculture Research Center, Egypt*

Abstract

This investigation was carried out to study the chemical composition, soluble, insoluble and total dietary fibers of some Egyptian fruit and vegetable peels. Also, determine the bioactive compounds such as an antioxidant activity, total phenolic, flavonoid and vitamin C, besides the minerals. Water holding capacity (WHC) and oil binding capacity (OBC) were also determined. The obtained results indicated that potato peels and tomato pomace contained the highest values of protein (15.18 and 14.39%, respectively). On the other hand, the highest values of total dietary fibers and water holding capacity (WHC) were recorded for tomato pomace (48.04% and 6.44 g H_2O/g dry matter, respectively). While, the prickly pear peels showed the highest value of ash (11. 84 %). Also, the same results indicated that orange peels had the highest value of carbohydrates (90.06 %). The same results indicated that mango kernel contained the highest fat, total phenolic and flavonoid (9.22%, 58.33% and 9.17 mg/g, respectively). The obtained results indicated that all the studied peels besides mango kernel and tomato pomace showed antioxidant activity percentages, very higher than wheat flour .Since antioxidant activity recorded ranges from 73.47 to 91.41% respectively compared to 17.78% for wheat flour. Also, the obtained results indicated also that mango kernel showed the highest contents of Mg which was recorded, 1627.96 mg/100g. Moreover, potato peels showed the highest contents of K and Fe which recorded 4443.26 and 28.27 mg /100g, respectively. Prickly pear peels showed the highest contents of Ca, Na and Mn (3470.90, 767.68 and 2.15 mg /100g, respectively).

Keywords: fruit and vegetable peels; bioactive components; chemical composition; Minerals and wastes.

1. Introduction

Fruits and vegetables play an important role in our diet and human life, thus the demand for these important food commodities has increased dramatically due to the growing world population and changing dietary habits [1].

Higher production and growth, and the lack of proper handling methods and infrastructure, have led to huge losses and waste of these important food commodities, as well as their components and by-products and residues. The United Nations Food and Agriculture Organization F.A.O. [2] has estimated that at least a third of the food produced in the world (estimated as 1.3 billion metric tons) is lost and wasted every year, the losses and waste of the horticultural commodities are the highest among all types of foods, reaching to 60% [3]. For example, the processing of mangoes yields about 11% of the peels, 13.5% of the seeds, 18% of the inoperable pulp, and 58% of the final product [4].

Fruit and vegetable wastes and their by-products are remaining in great amounts during industrial processing and hence represent a serious problem, as it exerts a harmful impact on the environment. So, it needs to be managed or it can be exploited. On the other hand, it is very rich in bioactive components, which are considered to have a beneficial effect on health [5].

Recently, it was reported that 39% of food waste is produced by the food manufacturing industries in developed countries [6]. Losses and waste are the unused or unconsumed parts of fruit, vegetable and other foodstuffs, as a result of morphological characteristics of the commodity, lack of proper handling operations, or simply discarded for diverse reasons. Besides this, by-products of horticultural commodities discarded after processing constitute a significant waste. However, the quantity and type of fruit and vegetable wastes vary from commodity to

*Corresponding author e-mail: may.amor1610@gmail.com

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commodity and morphological components, including leaves, roots, tubers, skin, pulp, seeds, stones, pomace, and so on [7].

Many fruits and vegetables generate at least 25% to 30% of waste materials, which are not further used [8].

Attempts have been performed broadly for the past few decades to develop methods and find different ways to utilize fruit and vegetable wastes therapeutically. Generally, agro-industrial wastes have been used extensively as animal feed or fertilizers. Recent reports have shown the development of high-value products (such as cosmetics, foods and medicines) from agro-industrial by-products [9]. Due to these compelling circumstances, researchers are working towards reducing food waste and identifying the potential crop remains and by-products that contain nutritional ingredients which are needed for the population; this leads to the domain of new value-added products in the market place [10].

In other words, a transformation of these wastes into food can have positive effects on a sustainable future.

The aim of this research is to identify the chemical composition and some bioactive components of the wastes of mango peels, orange peels, prickly pear peels, potato peels, mango kernels and tomato pomace. In order to, replace wheat flour72% extraction, by different levels of these wastes to utilize its bioactive compounds in some products.

2. Materials and methods

2.1. Materials.

- Raw Materials

a. Wheat flour (72% extraction) was obtained from the local market.

b. Mango peels, mango kernels (Mangifera indica L.), orange peels (Citrus sinensis), potato (Solanum tuberosum L.) peels and tomato pomace (Lycopersicon esculentum) were obtained from fruits and vegetables which obtained from Al-Obour market and processing them to obtain wastes from them to ensure their quality, Cairo, Egypt, except prickly pear (Opuntia ficus-indica) peels which was obtained from local market.

2.2. Methods

2.2.1. Preparation of peels powder

The obtained peels were washed with tap water to remove any dirt particles. The peels were spread in a thin layer on trays and dried at 50 C° using a cross-flow drier (Fisher Scientific, USA) for a time ranging between 12hrs. to 24 hrs. according to the type of peels. Mango peels and mango kernels were dried for 18 hrs. to a moisture content of around 10 % and orange peels were dried for 24 hrs.[11].

The potato peels were dried for 12 hrs. [12]. While the prickly pear peels was dried at 50 °C until completely dried [13]. Tomato pomace was dried at 60 °C for 18 hrs. [14].

The dried peels were ground into a fine powder at a high mixer speed (Moulinex, Adocia 1000w, France). Then, the materials were sifted through a 45mesh sieve Laboratory test sieve, in Milano, Italy except prickly pear peels were sifted by a 25mesh sieve. The obtained powders were packed in polyethylene bags and stored at 4 ± 1° until used.

3. Analytical methods.

3.1. Chemical composition of raw material.

Proximate chemical contents of mango peels, mango kernel, orange peels, prickly pear peels, potato peels and tomato pomace powder including moisture, protein, fat and ash were determined according to the method of the [15]. Carbohydrate was calculated by difference using the following equation:

% Total carbohydrates =100 – [%moisture + %ash +% fat +% protein]. However, Soluble, insoluble and total dietary fiber content was determined enzymatically according to the method described [16].

3.2. Determination of vitamin C

Vitamin C mg/100gm was determined as the method of [15].

3.3. Determination of the antioxidant activity of raw materials.

The antioxidant activity of the previously obtained powder of the raw materials under study was determined using free radical by 2,2 - Diphenyl- 1-picrylhdrazyl DPPH as a reagent has radical scavenging activity according to the calorimetric method described [17]. The percentage inhibition of the DPPH radical by the samples was calculated according to the formula method described [18].

Inhibition% = Ac 0 – AA t / Ac 0 × 100

Where:

Ac 0 is the absorbance of the control at time = 0 min

AA t is the absorbance of the antioxidant at time =1hr.

3.4. Determination of total phenolic compounds of raw materials.

Phenolic compound contents of the powders samples were determined calorimetrically using Folin–Ciocalteu reagent as mg/ g gallic acid equivalent according to the method described [19].

3.5. Determination of total flavonoid of raw materials.

Total flavonoids compound contents as mg/ g catechin equivalent were determined according to the method described [20].

3.6. Determination of minerals of raw materials.

The minerals, i.e, magnesium (Mg), Sodium (Na), potassium (K), calcium (Ca), phosphor (P), Iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu) were determined using Agilent Technologies 4210 MP-AES according to the method of [15].

3.7. Determination of water -holding and oil-binding capacity.

Determination of water holding capacity and oil binding capacity were carried out according to the method described by [21]. Distilled water (25 mL) or commercial corn oil was added to 0.5 g of mango peel powder or mango kernel powder, orange peels, prickly pear peels, potato peels, tomato pomace and wheat flour, weighed and the WHC or OBC were calculated as g water or oil per g of dry sample, respectively.

3.8. Statistical analysis

All data were analyzed using Co Stat, version 3.03 for personal computers according to the method described [22]. The tests used were the ANOVA test and descriptive statistics test. A treatment effect was assumed to be statistically significant at $P < 0.05$. A randomized complete block design with two factors was used for the analysis of all data with three replications for each parameter. The treatment means were compared by the least significant difference (L.S.D.) test as given according to the method described by [23] using Assistant program.

4. Results and discussion.

4.1. Chemical composition of raw materials

From the results presented in Table (1) it could be noticed that potato peels and tomato pomace contained the highest values of protein (15.18 and 14.39%, respectively), which were not significantly ($P < 0.05$) different. While mango peels powder showed the lowest value 4.50% and the same data statistically analyzed and the obtained results found the mango peels, mango kernel, prickly pear peels and orange peels were not significantly ($P < 0.05$) different. The same results indicated that mango kernel contained the highest value of fat 9.22%, while the lowest value was observed for mango peels 1.07% and from statistical analyses it was found that mango peels , potato peels and wheat flour 72% extraction were not significantly ($P < 0.05$) different concerning fat . Prickly pear peels showed the highest value of ash followed by potato peel and tomato pomace (11.84 %, 7.99 % and 6.94%, respectively). Also, results indicated also that orange peels contained the highest value of carbohydrates (90.06%) and it was found not significantly ($P < 0.05$) different from orange peels and mango peels for carbohydrates content.

These results were found to be in agreement with the results of [24]. They found that protein, fat and ash contents were 3.6%, 7.76 % and 1.23 % and 8.15 %, 3.88 % and 1.46% for mango peels and mango kernel, respectively. The obtained results were also found to agree with those of [25] .They reported that orange peel powder contained 80.06% carbohydrate, 5.6% crude protein, 2.3% fat and 3.62% ash. However, these results of the chemical composition of prickly pear peels confirmed by those of [26]. They found that prickly pear peels contained 4.50% protein, 6.99 % fat and 8.00 % ash. Moreover, similar results were reported by [27].They reported that prickly pear peels contained 3.58% protein, 2.12 % fat, 12.71 % ash and 73.41% total carbohydrates. The obtained results were also found to agree with those of [28]. They found that potato peels contained 11.17% protein, 2.09 % fat, 7.24 % ash and 72.53% total carbohydrates. Also, similar results were reported by [29] .They found that potato peels contained 10.65 % protein, 1.33 % fat, 5.01 % ash and 72.26% total carbohydrates. These results confirmed those obtained by [30] .They reported that tomato pomace contained 18.25% protein, 0.65 % fat and 7.25 % ash. The obtained results were found also to be agreed with those of [31]. They found that it contained 16.31% protein, 5.38 % fat and 3.49% ash.

Table 1 Chemical composition % of raw materials on dry weight basis.

Chemical constituents %					
Raw materials	Moisture	Protein	Fat	Ash	Total carbohydrate
Wheat flour 72%	12.53 ^{b} ± 0.92	11.42 ^{b} ± 0.58	1.41 ^{de} ± 0.25	0.66 ^{g} ± 0.13	86.51 ^{b} ± 0.20
Mango peels	6.62 ^{c} ± 0.28	4.50 ^{c} ± 0.81	1.07 ^{e} ± 0.08	4.60 ^{d} ± 0.02	89.83 ^{a} ± 0.72
Mango Kernels	6.48 ^{c} ± 0.60	4.88 ^{c} ± 0.27	9.22 ^{a} ± 0.76	2.41 ^{f} ± 0.17	83.49 ^{c} ± 0.63
Orange peels	1.70 ^{e} ± 0.17	4.68 ^{c} ± 0.33	1.93 ^{d} ± 0.51d	3.33 ^{e} ± 0.13	90.06 ^{a} ± 0.28
Prickly Pear Peels	13.54 ^{a} ± 0.35	5.52 ^{c} ± 0.60	5.63 ^{b} ± 0.64	11.84 ^{a} ± 0.93	77.01 ^{d} ± 0.89
Potato peels	3.79 ^{d} ± 0.11	15.18 ^{a} ± 1.83	1.29 ^{de} ± 0.30	7.99 ^{b} ± 0.51	75.54 ^{e} ± 1.65
Tomato pomace	3.38 ^{d} ± 0.26	14.39 ^{a} ± 1.58	2.96 ^{c} ± 0.39	6.94 ^{c} ± 0.24	75.71 ^{e} ± 1.42
LSD $_{.05}$	0.82	1.798	0.821	0.718	1.701

Values in the same column with different letters are significantly different $p \leq 0.05$.

4.2. Soluble, insoluble and total dietary fiber contents of raw materials

From the presented results in Table (2), it could be noticed that wheat flour 72% extraction showed the lowest content of total dietary fiber in comparison with other raw materials under study. The highest value of total dietary fiber was recorded for tomato pomace 48.04% followed by orange peels 44.33 %. While , the lowest value was observed for wheat flour with 72% extraction 9.37 %. Similar results also indicated that potato peels, prickly pear peels and mango kernel were found to be not significantly different in between.

The results presented in Table (2) revealed that all the studied peels in addition to mango kernels and tomato pomace contained total dietary fiber in percentages higher than that of wheat flour. Such indicated that the addition of these peels to wheat flour could lead to an increase in its dietary fibers contents. The dietary fibers has important benefits for health, especially because of its effect on the digestive system; they are protective against some types of cancer , lower blood cholesterol levels and helps in weight control [32].

These results were in a agreement with [33]. They reported that soluble dietary fiber, insoluble dietary fiber and total dietary fiber contents of mango peels were 12.8%, 27.8% and 40.6%, respectively. Also, they reported that total dietary fiber content was in the range of 40.6–72.5%. Moreover, these results confirmed those of [34]. They found that soluble dietary fiber, insoluble dietary fiber and total dietary fiber contents of mango peels were 20.0 %, 34.2 % and 54.2%, respectively. The obtained results were also found to agree with those of [1]. They found that soluble dietary fiber, insoluble dietary fiber and total dietary fiber contents of orange peels were 9.41 %, 47.6% and 57%, respectively.

The obtained results were also found to agree with those of [27]. They found that soluble dietary fiber and total dietary fiber contents of prickly pear peels were 12.80% and 33.0%, respectively. Moreover, tomato pomace results agreed with those [31]. They found that soluble dietary fiber, insoluble dietary fiber and total dietary fiber contents of potato peels were 4.91%, 55.03% and 59.94%, respectively. The obtained results were found also to be agreed with those of [35] .They reported that tomato pomace contained 50.03% total dietary fiber.

Table 2 Soluble, insoluble and total dietary fiber contents of raw materials on dry weight basis.

Raw materials	Soluble dietary fiber %	Insoluble dietary fiber %	Total dietary fibers
Wheat flour 72%	5.80 e ± 0.30	3.57 f ± 0.12	9.37 e ± 0.40
Mango peels	17.80 a ± 0.40	20.27 d ± 0.12	38.07 c ± 0.31
Mango Kernels	2.60 f ± 0.50	25.23 c ± 1.10	27.84 d ± 0.93

Orange peels	11.50 c ± 2.26	32.83 b ± 0.15	44.33 b± 2.41
Prickly Pear peels	13.87 b ± 0.11	14.40 e ± 0.53	28.26 d ± 0.58
Potato peels	3.50 f ± 1.00	24.84 c ± 1.21	28.34 d ± 2.21
Tomato pomace	8.79 d ± 0.19	39.25 a ± 0.56	48.04 a ± 0.39
LSD $_{.05}$	1.707	1.205	2.321

Values in the same column with different letters are significantly different p≤ 0.05.

4.3. Bioactive compounds of raw materials

The results presented in Table (3) indicated that mango peels showed the highest value of antioxidant activity (91.41%). The same results of statistical analyses showed also that no significant differences were observed between potato peels, mango kernel and tomato pomace for antioxidants. While the lowest value was observed for wheat flour 72% extraction (17.78%). The same results indicated that mango kernel had the highest values of total phenolic and flavonoids (58.57 and 9.17 mg/g, respectively), while the lowest value of total phenolic and flavonoids were recorded for wheat flour 72% extraction (1.50 and 1.37 mg/ g, respectively). The same results indicated that orange peels contained the highest values of vitamin C (54.7 mg/100g), while the lowest value of vitamin C was observed in wheat flour 72% extraction (0.0 mg/100g).

The obtained results indicated that all the studied peels besides mango kernel and tomato pomace showed antioxidant activity percentages, very higher than that of wheat flour. Also, similar results were observed for total phenolic. Some of the studied peels such as mango peels and potato peels in addition to mango kernel showed also higher content of flavonoids in comparison with wheat flour. The antioxidants able to reduce free radical activity and scavenge free radicals [36]. The demand for antioxidant substances naturally found in fruits and vegetables has increased since the use of those substances in products has been considered due to health benefits to consumers such as the reduction in the incidence of cardiovascular diseases and cancer. Moreover, natural antioxidants can be more effective in retarding food oxidation. Moreover, natural antioxidants can be more effective in retarding food oxidation. In addition, natural antioxidants are available and not costly and total phenolic compounds that may well integrate into the diet [37].

These results were found to be in agreement with those of [24]. They found that mango kernel powder was characterized by a significantly high amount of phenolic compared to mango peels powder 23.90 and 19.06 mg/g, respectively. The total phenolic and total flavonoids of mango kernel powder were much higher than that reported for peels of mango; also, they reported that these differences in phenolic contents might be due to mango cultivars, geographical location, extraction conditions and used different standard equivalents [38]. These results were found to be also in agreement with those of [39]. They reported that "Espadia" variety contained 33.7% of total phenolic. Also, the orange peels contained 66.50 mg/100g vitamin C, 14.10 mg/g phenolic and 56.29 % antioxidant activity [40] .Also, these results confirmed those of [41] .They reported that orange peels contained 16.12mg/g total phenolic , 2.06 mg/g total flavonoid and 88.65 % antioxidant activity.

Prickly pear peels contained 17.1 mg/g total polyphenols [27]. The obtained results confirmed those of [29]. They reported that potato peels Lady Rosetta contained and 62.32 % antioxidant activity. Also, these results confirmed those of [42]. They found that potato peels contained 80.86% antioxidant activity and 3.78 mg/g total phenolic. These results confirmed those obtained by [43] .They reported that potato peels contained 19.7 mg/100g vitamin C.

Tomato pomace contained 4.27mg/g total phenolic and 80.34% antioxidant activity [31]. Also, these results confirmed those of [44] they reported that Tomato pomace contained 17.68 mg/100g vitamin C and 70.30% antioxidant activity.

Table 3 .Bioactive compounds of raw materials

Raw materials	Antioxidant activity %	Total phenolic mg/ g	flavonoids mg/ g	Vitamin C mg/100g
Wheat flour 72% ext.	17.78 ^{e} ± 0.7	1.50 ^{g} ± 0.02	1.37 ^{f} ± 0.01	00.00 ^{f} ± 0.0
Mango peels	91.41 ^{a} ± 0.20	46.13^{b} ± 0.01	5.38 ^{b} ±0.035	17.22 ^{d} ± 1.73

Mango Kernels	88.49 [b] ±1.49	58.33 [a] ± 0.23	9.17 [a] ± 0.15	22.95 [b] ± 0.7
Orange peels	73.47[d] ± 1.89	10.91[d] ± 0.25	1.71 [e] ± 0.02	54.7 [a] ± 0.87
Prickly Pear peels	83.44 [c] ± 0 .88	14.04 [c] ± 0.16	2.29 [d] ± 0.05	12.61[e] ± 0.16
Potato peels	88.85 [b] ± 1.55	7.35 [e] ± 0.23	4.82 [c] ± 0.22	13.94 [e] ± 1.25
Tomato pomace	87.71[b] ± 0.28	4.88 [f] ± 0.05	1.66 [e] ± 0.01	19.01[c] ± 0.64
LSD $_{.05}$	2.052	0.299	0.186	1.655

Values in the same column with different letters are significantly different p≤ 0.05.

4.4. Minerals contents of raw materials

The results presented in Table (4) indicated that potato peels showed the highest contents of K (4443.26 mg/100g), Fe (28.27 mg/100g) and Zn (218.62 mg/100g) . The results of statistical analyses showed that all samples of peels beside mango kernels were found to be significantly different from wheat flour 72% extraction for Mg, Na, Ca, K and P. However, mango and orange peels were found to be not significantly different from wheat flour 72% extraction for Zn. The same results indicated that all samples were not significantly different from wheat flour 72% extraction for Cu and also for Mn with except of prickly pear peels. Prickly pear peels showed the highest contents of Ca (3,470.90 mg/100g), Na (767.68 mg/100gm) and Mn (2.15 mg/100g). Moreover, prickly pear showed high contents of Mg, Ca, P and Fe and these results confirmed those present in Table (1) which indicated that prickly pear peels showed the highest content of ash compared with other raw materials.

In general, the obtained results revealed that the fruits and vegetables peels under study in addition to mango kernel and tomato pomace could be considered a good source of minerals, especially Ca, Mg, K, Fe, P and Zn .Therefore, it could be used for the fortification of wheat flour to raise its mineral contents since it was present in few amounts compared to those of the studied materials. The importance of minerals for nutrition was demonstrated through many searches. The minerals are essential for a wide variety of metabolic and physiologic processes in the human body. They are useful for many actions in the body like muscle contraction, normal heart rhythm, nerve impulse conduction, oxygen transport, oxidative phosphorylation, enzyme activation, immune functions, antioxidant activity, bone health, and acid-base balance of the blood. An adequate daily amount of minerals is necessary for optimal functioning [31].

The composition variations of minerals are possibly due to varietal differences in soil type, environmental and climatic conditions and fruit maturity stage [45]. Also, the composition of minerals in the grain is obviously determined by the concentration of available minerals in the soil [46].

These results were found to be in agreement with those of [47] .They found that wheat flour contained K, Mg, Ca , Zn, Fe and Cu at levels of 160 , 50, 30 ,1.2 , 2.4 and 0.8 mg/100gm , respectively. These results were found to be in agreement with those of [48].They found that mango peels contained 12.79 mg/100g for Fe and orange peels contained 6.84 mg/100 g for Zn.

The obtained results were found also to agree with those of [41]. They found that Ca, K, Mn, Cu, Zn and Fe contents of orange peels were 1340, 480, 0.4, 3.27, 0.3 and 9.37 mg/100g, respectively.

Also, the obtained results were found also to be agreement with those of [49] .They reported that Ca, K, Fe and Mg contents of prickly pear peels were 2090, 3430, 8.31 and 322 mg/100gm, respectively. Also, the obtained results were found also to be agreement with those of [26]. They found that Na and Zn contents of prickly pear peels were 925.0 and 90.0 mg/100 mg, respectively.

4.5. Water holding capacity and oil binding capacity of raw materials

From the results presented in Table (5) it could be noticed the highest value of water holding capacity was recorded for tomato pomace (6.44g H_2O/g dry matter) followed by orange peel (5.65g H_2O/g dry matter) and it was not significantly different in between and this might be due to its high dietary fiber contents [50]. However, the lowest value was observed for mango kernel (1.79g H_2O/g dry matter).

Table 4 Minerals content as (mg/100 g) of raw materials

Raw materials	Minerals mg / 100 g								
	Mg	Na	K	Ca	P	Fe	Zn	Mn	Cu
Wheat flour 72%	59.64 ^{f} ± 9.63	2.93 ^{e} ± 0.07	172.01 ^{f} ± 11.66	10.00 ^{g} ± 2.45	30.83 ^{f} ±12.96	2.26 ^{e} ± 0.75	0.98 ^{e} ± 0.19	0.56 ^{b} ±.0.41	0.61 ^{a} ± 0.22
Mango peels	173.64 ^{e} ± 5.55	260.89 ^{c} ± 30.64	2418.71 ^{d} ± 31.6	945.65 ^{c} ± 27.66	175.35 ^{d} ± 5.46	7.00 ^{cd} ±3.18	4.53 ^{e} ± 0.65	1.03 ^{ab} ± 0.49	1.33 ^{a} ± 0.41
Mango Kernels	1627.96 ^{a} ± 32.84	119.27 ^{d} ± 6.06	1576.46 ^{e} ± 65.17	212.65 ^{f} ± 7.94	214.55 ^{c} ± 10.84	4.58 ^{de} ± 0.47	15.36 ^{d} ± 5.47	1.02 ^{ab} ± 0.04	1.21 ^{a} ± 1.03
Orange peels	629.11 ^{d} ± 11.13	351.95 ^{b} ± 27.24	1615.51 ^{e} ± 64.7	1411.22 ^{b} ± 12.85	83.31 ^{e} ± 7.21	5.11 ^{cde} ± 1.02	3.15 ^{e} ± 1.34	0.67 ^{b} ± 0.38	0.84 ^{a} ± 0.04
Prickly Pear Peels	214.45 ^{e} ± 15.85	767.68 ^{a} ± 17.55	3795.68 ^{c} ± 19.55	3470.9 ^{a} ± 44.39	68.67 ^{e} ± 6.66	8.07 ^{c} ± 2.14	59.87 ^{c} ± 8.93	2.15 ^{a} ± 1.09	0.73 ^{a} ± 0.31
Potato peels	1333.41 ^{c} ± 44.06	265.42 ^{c} ± 4. 86	4443.26 ^{a} ± 51.41	576.62 ^{d} ± 35.51	252.62 ^{b} ±16.01	28.27 ^{a} ±2.22	218.62 ^{b} ± 2.84	1.45 ^{ab} ± 0.86	1.21 ^{a} ± 0.26
Tomato pomace	1535.82 ^{b} ± 27.31	265.42 ^{c} ± 14.13	3964.93 ^{b} ± 69.77	511.52 ^{e} ± 25.35	412.17 ^{a} ± 10,97	24.34 ^{b} ± 1.82	232.82 ^{a} ± 7.97	1.29 ^{ab} ± 0.81	1.11 ^{a} ± 1.01
LSD .05	43.223	31.39	87.462	45.228	18.583	3.293	8.999	1.188	1.045

Values in the same column with different letters are significantly different p≤ 0.05.

Concerning the oil binding capacity the highest value was recorded for orange peels (3.83 g H_2O/g dry matter), while the lowest was observed for wheat flour 72% extraction, (1.1g H_2O/g dry matter). It was also observed that there were no significant differences between mango peels, mango kernels, orange peels, potato peels and tomato pomace for oil binding capacity. These results were found to be in agreement with the results of [50].They reported that The water holding capacity for wheat flour and tomato pomace were 1.01 and 7.25 g water/g solid, respectivelyhe water holding capacity and oil binding capacity of orange peels were 5.9g H_2O/g dry matter and 4.0 g oil /g dry matter, respectively[51] .

The water-holding capacity and oil- binding capacity of mango peels were 4.3g H_2O/g dry matter and 2.2 g oil /g dry matter, respectively. Also, the water holding capacity and oil binding capacity of mango kernel were 1.9g H_2O/g dry matter and 1.8 g oil /g dry matter, respectively [21]. Moreover, the water holding capacity and oil binding capacity of prickly pear peels were 3.70 H_2O/g dry matter and 2.49 g oil /g dry matter, respectively [52].

Also, the same results were agreement with those of [53]. They found that water holding capacity and oil binding capacity of prickly pear peels were 3.99 H_2O/g dry matter and 1.95 g oil /g dry matter , respectively and they found that water holding capacity and oil binding capacity of wheat flour were 2.12g H_2O/g dry matter and 1.15 g oil /g dry matter , respectively. Also, the water-holding capacity and oil- binding capacity of potato peels were 4.097 gH_2O/g dry matter and 4.398 g oil /g dry matter, respectively [54].

Table 5 Water holding capacity and oil binding capacity of raw materials on dry basis

Raw materials	WHC (g H_2O/g)	OBC (g oil/g)
Wheat flour 72%	2.42 ^{e} ± 0.1	1.10 ^{c} ± 0.08
Mango peels	5.04 ^{bc} ± 1.35	3.13 ^{ab} ± 1.17
Mango Kernels	1.79 ^{e} ± 0.01	2.9 ^{ab} ± 0.15
Orange peels	5.65 ^{ab} ± 0.11	3.83 ^{a} ± 1.01

Prickly Pear peels	$4.28^{cd} \pm 0.27$	$2.17^{bc} \pm 0.25$
Potato peels	$3.70^{d} \pm 0.14$	$3.20^{ab} \pm 0.90$
Tomato pomace	$6.44^{a} \pm 0.45$	$2.66^{ab} \pm 0.73$
LSD.05	0.966	1.213

Values in the same column with different letters are significantly different $p \leq 0.05$.

3- Conclusions

The obtained results revealed that the peels of fruits and vegetables are rich in many important nutrients, and this was evident from the chemical composition, in addition to its high content of dietary fibers and antioxidants that protects against many diseases, in addition to, high content of minerals. Therefore, it could be utilized in bakery products for fortification and benefits from its high nutritive value.

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