Original Research Article

Utilization of treated seed kernel flours of some fruits in biscuit manufacture

Abstract: During the processing of fruits, large quantities of wastes are generated, these by-products contain large amounts of oil, starch and protein that can be exploited due to their good nutritional, technological, and functional properties. However, due to the presence of several antinutritional factors, such as polyphenolic compounds, phytic acid, cyanogenic glycoside and oxalates, the use of fruit wastes in human food is limited. The present investigation was aimed to study the effect of soaking and heating on antinutritional factors. It also examines the effect of substituting defatted apricot, peach, and mango seed kernel flours for wheat flour in various ratios (5, 10, and 15%) on the chemical composition, physical features, and sensory properties evaluation of biscuits. The results revealed a significant effect of soaking and heating on the antinutrients, detoxification led to a significant ($p \leq 0.05$) decrease in antinutritional factors with ratios 43.63-52.73% total phenols, 78.17-86.16% tannins, 45.92-54.34% phytic acid and 40.42-44.70% oxalates, along with the complete removal (100%) of hydrocyanic acid (HCN). Wheat biscuit contained 3.20% moisture, 6.31% protein, 15.46% fat, 0.64% crude fiber, 1.25% ash and 76.33% carbohydrate. Highly acceptable biscuits could be obtained by incorporating 5% of defatted apricot, peach and mango kernel flours in the wheat biscuits formulation. As a by-product, apricot, peach and mango kernels offer an exciting potential as a food ingredient permitting to enrich biscuits and enlarge the food base for consumers.

Keywords Fruits, By-product, Seed kernels, antinutritional factors, Biscuits, Physical characteristics, Sensory evaluation

Introduction

The demand for fruit and vegetable has expanded significantly, as the world population has grown and consumers have become more aware of the health advantages of eating fruit and vegetable. During the processing of fruit and vegetable, large quantities of liquid and solid wastes are generated [**1**]. Due to their positive nutritional, technological and functional features, food-processing wastes are potential sources of important substances such as dietary fiber, antioxidants, essential fatty acids, antimicrobials, and minerals that can be utilized. Fruit peel, stone, and seed kernel are among the wastes produced as a result of increased consumption of fruit pulp in the fruit industry [**2**].

Apricot fruits is a part of Egyptian diets, is nutritionally contains organic acids, carbohydrates, vitamins and minerals. Due to its short shelf life, apricot fruits is available all year in processed and dried forms (marmalade, jam, nectar and jellies), resulting in a large quantity of apricot kernel, which are particularly high in fat and protein, as well as a considerable amount of minerals and crude fiber, may be valuable in human nutrition. The oil and protein content of apricot kernels has been found to be in the range of 28.0-66.7 and 14.0-45.0 g/100 g, respectively. A few researches on the use of apricot kernels in wheat flour enrichment and the development of cake, biscuit, noodle, and yoghurt have been published. However, the presence of the potentially deadly cyanogenic glycoside amygdalin, as well as a high amount of bitter-tasting antinutritional components in wild apricot varieties, has inevitably limited the use of apricot kernel in the food industry [**3**, **4**].

Peaches (*Prunus persica*), which belong to the *Rosaceae* family, are one of the most popular summer fruits. The fruits have a slightly sour and astringent flavour and are low in calories but have high nutritive value. Peach fruits contain natural sugars (glucose, sucrose and fructose), organic acids (malic and citric acids), crude fiber and no saturated fat are found in them. During peach processing, the kernels are normally removed and become a by-product. Considering that peach kernels represent 5 to 10% of the total weight of the fruit, depending on the type, ten thousand tons of waste are generated annually, which is currently underutilized. Peach seed kernels contain about 48.30 fat, 27.20 protein, 3.35 ash and 13.14% total carbohydrates [**5-7**].

Mangoes are members of the genus *Mangifera*, which includes a large number of tropical fruiting trees in the *Anacardiaceae* flowering plant family. Mango seeds are wasted in large quantities after consumption or industrial processing of the fruits. The main waste product from mango processing is mango seed, which accounts for 30-45% of the total fruit weight depending on its variety. Mango seed kernels are one such example, as they contain significant amounts of edible oil and proteins and have the potential to be used in a variety of food products. Furthermore, the mango seed kernel includes certain interesting compounds that can be used as natural antioxidants in food products. The seed kernel flour has a carbohydrate content of 72.73%, 4.59% protein, 13.68% fat and 1.69% ash [**8-10**].

Biscuits are the most widely consumed bakery product in the world, biscuits are one of the most popular snacks among both children and adults. Some of the reasons for their widespread popularity include their ready to eat nature, low cost, high nutritional content, variety of flavors, and longer shelf life. It is regarded as one of the greatest supplementary foods for distributing to undernourished children through development agencies [**11**, **12**].

Materials and Methods

Materials

Mango (*Mangifera indica*), apricot (*Prunus armeniaca*) and peach (*Prunus persica*) fruits were procured from local market at Assiut city, Egypt.

Chemicals

All chemicals used in this study were produced by Sigma Chemical Co. (U.S.A) and obtained from El-Gomhouria Company, Assiut city, Egypt.

Preparation of fruit seed kernel flours

Seeds were removed from fruits and the seeds outer shell was washed with water to remove the remaining fruit pulp, and sun-dried for 3 weeks, then the outer shell of seeds was cracked manually and the kernels was ground to fine flour by laboratory mill (Braun, Germany).

Removal of antinutritional compounds

The kernels were divided into two parts, raw (without treatment) and another part soaked in distilled water for 48 h with occasional decantation and replacement with an equivalent amount of water until the water remained colourless, then heating at 100 °C for 30 min in 0.1% sodium bicarbonate [**13**], then dried at (50 °C) in an electric oven for 24 h and ground into a fine flour. Then kept in air-tight polythene bags and stored at (4 °C) until utilization and analysis according to the method described by[**14**] with some modifications.

Defatted fruit seed kernel flours

Hexane was used to extract the oil from the seed kernel flour by immersing in an extractor in order to get rid of the existed oil. The solvent was removed by a rotary evaporator.

Preparation of biscuit

Biscuits were prepared by using the method of [**15**]. Defatted apricot, peach and mango kernel flour was substituted for wheat flour at level 5, 10 and 15% according to the formula as described in **Table (1).**

Table (1): Formula of biscuits

Ingredients (gm)	Control	5% WF-DAKF	10% WF-DAKF	15% WF-DAKF	5% WF-DPKF	10% WF-DPKF	15% WF-DPKF	5% WF-DMKF	10% WF-DMKF	15% WF-DMKF
Wheat flour	100	95	90	85	95	90	85	95	90	85
Sugar	30	30	30	30	30	30	30	30	30	30
Shortening	20	20	20	20	20	20	20	20	20	20
Sodium chloride	1	1	1	1	1	1	1	1	1	1
Sodium bicarbonate	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ammonium bicarbonate	1	1	1	1	1	1	1	1	1	1
Baking powder	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Water	16	16	16	16	16	16	16	16	16	16

Control (100% wheat flour 72% extraction).
WF-DAKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted apricot kernel flour.
WF-DPKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted peach kernel flour.
WF-DMKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted mango kernel flour.

Analytical methods

Determination of total phenolic compounds

Total phenol compounds (TPC) was calculated in the ethanolic extracts, according to the Folin-Ciocalteu method with slight modifications [**16**].

Determination of tannin

The tannin content was determined according to the method of [17]**.** The absorbance of the reaction mixture was measured at 725nm in a spectrophotometer. The tannin content was calculated as an equivalent of tannic acid.

Determination of phytic acid

The phytic acid (IP6) was determined in terms of its phosphorous content, using the method described by [**18**]. The phytic acid was calculated from phytate phosphorus from the weight ratio of phosphorus atoms per molecule of IP6 (1:3.52) according to [**19**].

Determination of oxalate

The titration method as described by [**20**] was followed to determine oxalate content. The oxalate content was calculated by taking 1ml of 0.05M $KMnO_4$ as equivalent to 2.2 mg oxalate [**21**].

Determination of hydrocyanic acid (HCN)

Hydrocyanic acid in seed kernel flours was estimated by the method given by [**22**]. The HCN content (mg/100g) in the sample was then calculated using following expression:-

$$\text{HCN (mg/100g)} = \frac{\text{Titer} \times 1.08 \times \text{Volume made up} \times \text{Aliquot taken}}{\text{Sample taken} \times \text{distillate taken}}$$

Chemical composition of biscuit:

Moisture, fat, protein, ash and crude fiber of sample were determined according to [**22**]. The carbohydrate was calculated by the difference. All determinations were in three replications, and the means were recorded.

Physical properties

Diameter (cm), thickness (cm), spread ratio and spread factor were determined in five biscuits and averages were recorded. Spread ratio and spread factor were calculated according to [**15**] as follow:

$$\text{Spread ratio} = \frac{\text{Diameter}}{\text{Thickness}}$$

$$\text{Spread factor} = \frac{\text{Spread ratio of sample}}{\text{Spread ratio of control}} \times 100$$

Sensory evaluation

Biscuit was evaluated sensory characteristics for color, taste, odor, texture and overall acceptability by using 9-Point Hedonic Scale sensory evaluation parameter according to [**23**].

Statistical analysis

Data were analyzed by analysis of variance (ANOVA) using SPSS 25-software statistical package program [**24**]. (Duncan) tests were used to determine the differences among means at the level of 0.05%.

Results and Discussion

Antinutritional factors in apricot, peach and mango kernel flours

The antinutritional factors, total phenolic compounds, tannins, phytic acid, oxalates and total cyanogenic in apricot, peach and mango kernel flours are presented in Table (2). The study revealed soaking with heating treatments to offer significant difference ($p \leq 0.5$) among concentration of antinutrients in raw and processed kernel flours. Nutrient binding compounds were found to be in lower concentration in processed kernel flours than its content in raw kernel flours.

Data in Table (2) indicated that mango raw kernel flours has the highest values for total phenolic compounds (986.50 mg/100g), tannin (513.76

mg/100g), phytic acid (212.63 mg/100g) and oxalate (38.59 mg/100), while it contained the lowest value for total cyanogenic (37.20 mg/100g). On the other hand, Data in Table (2) showed that apricot and peach raw kernel flours has the significantly ($p \leq 0.05$) highest values for total cyanogenic (189.90 mg/100g) and (165mg/100g); respectively, than that in the mango raw kernel flour.

Cyanogenic glycosides yield hydrogen cyanide (HCN) upon hydrolysis and thus toxic at certain concentrations. It's also a known inhibitor of the respiratory chain inhibiting cytochrome oxidase. Short-term exposure to high levels of (HCN) produces almost immediate collapse, respiratory arrest and death. The results in Table (2) referred that the cyanogenic glycosides were completely destroys (100% reduction) as a result of soaking and heating treatments. This reduction is higher than that reported by [**5**, **25**, **26**].

The study showed that soaking with heating treatment significantly ($p \leq 0.05$) reduced the levels of tannins in the processed kernel flours. Soaking and heating reduced the tannins levels by 78.17, 80.00 and 86.16% for peach, mango and apricot kernel flours; respectively. This processing method is effective in removing 43.63 to 52.73% of total phenolic compounds; the highest removing percentage of total phenolic compounds was obtained in peach kernel flour. These results are in agreement with those obtained by [**27-29**]

Combined treatments (soaking with heating) produced a significant ($p \leq 0.05$) change on the phytic acid of processed kernels compared to the raw. The highest reducing percentage of phytic acid was obtained in peach kernel flour (54.34%). The reduction in phytic acid as a result of soaking be due to degradation of phytic acid by the enzyme phytase, which is usually activated by soaking. It has been reported that high consumption of phytate can reduce absorption of essential elements like zinc, calcium, iron and magnesium [**30**]. These results are also in agreement with those obtained by [**26**, **31**].

The values of oxalate content as presented in Table (2), are 15.62, 18.70 and 38.59 mg/100g for peach, apricot and mango raw kernel flours; respectively.

Whereas, 9.16, 11.14 and 21.34 mg/100g in peach, apricot and mango processed kernel flours; respectively. The highest reducing percentage of oxalate was observed in mango kernel flour (44.70%) compared to (40.42%) and (41.35%) for apricot and peach kernel flours. A significant ($p \leq 0.05$) decrease was observed when the raw kernel flours was compared with processed kernel flours. Similar observation was reported by [**26**, **32**, **33**].

Table (2): Effect of treatment (soaking with heating) on antinutritional factors in apricot, peach and mango kernel flours mg/100g on dry weight basis:

Samples		Total phenols	Tannins	Phytic acid	Oxalates	HCN
Apricot	Raw	136.73 ±3.59[c]	194.70 ±4.41[b]	123.66 ± 2.18[b]	18.70 ±0.88[c]	189.90 ±9.91[a]
	Treated	70.66 ±2.55[e]	26.94 ±1.30[f]	62.41 ±3.71[d]	11.14 ±0.33[e]	0.00
Peach	Raw	116.35±3.47[d]	156.44 ± 0.95[c]	117.15 ±2.90[c]	15.62 ±0.44[d]	165 ±7.49[b]
	Treated	54.99 ±2.83[f]	34.14 ±0.78[e]	53.49 ±1.24[e]	9.16 ±0.67[f]	0.00
Mango	Raw	986.50 ±9.00[a]	513.76 ±6.98[a]	212.63 ±3.82[a]	38.59 ±0.59[a]	37.20 ±3.74[c]
	Treated	556.04±6.05[b]	102.74 ±1.74[d]	114.98 ±3.32[c]	21.34 ±0.44[b]	0.00

Values are the mean of triplicate determinations with standard division.
The different letters at the column means significant differences at ($P \leq 0.05$) and the same letters means no significant differences.

Chemical composition of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Chemical composition of biscuit baked from wheat flour substituted with different levels of defatted apricot, peach and mango kernel composite flours are presented in Table (3). The control of wheat flour biscuit contained 3.20% moisture, 6.31% protein, 15.46% fat, 0.64% crude fiber, 1.25% ash and 76.33% carbohydrate. The approximate composition of wheat biscuit reported in this work are agreement with that reported by Youssef et al. [**34**] and Gumte et al. [**35**].

Moisture content of biscuit substituted with defatted kernel flours was ranged from 3.29 to 3.55%. Data shows that moisture content increased gradually by increasing the defatted kernel flours level in biscuits this may be due to the higher content of moisture in defatted kernel flours compared with moisture content of wheat flour, or may be due to increased water absorption of crude fiber present in defatted kernel flours with higher percentage compared to wheat flour (control). Similar results have been previously reported by [**11**, **28**].

It was observed from Table (3) that, the protein content of biscuits was significantly ($p \leq 0.05$) increase as the incorporation level of defatted kernel flours increases. The biscuit baked from 85% wheat flour and 15% defatted apricot kernel flour (DAKF15) had the highest protein content, followed by DPKF15, DAKF10 and DPKF10 biscuit samples. The lowest protein content for biscuit made from wheat-defatted kernel composite flour was recorded for DMKF5 biscuit sample. These data are in agreement with [**36**, **37**].

Significant differences in fat content of biscuit made from wheat-defatted kernel composite flours were also observed, the mean values showed high fat content for WF-DAKF15 (15.95%), followed by WF-DPKF15 (15.87%), WF-DAKF10 (15.80%) and WF-DPKF10 (15.73%) biscuit samples. The lowest of fat content (15.52%) was recorded for WF-DMKF5 biscuit sample. [**33**, **36**], reported similar findings previously.

Crude fiber and ash contents of all biscuit made from composite flours were higher than that of control and increased significantly ($p \leq 0.05$) with increment the substituting of wheat flour with defatted kernel flours. Among the biscuit made from composite flours, WF-DPKF15 biscuit showed high crude fiber content (1.31%) followed by WF-DAKF15 biscuit sample (1.23%). Also, the highest ash content (1.39%) recorded for WF-DPKF15, while the lowest content (1.27%) was found in WF-DMKF5 biscuit. The increase in ash and crude fiber contents of biscuit made from composite flours may be due to the higher ash and fiber contents of defatted kernel flours than in wheat flour. Similar findings were reported previously by [**29**, **38**].

On the other hand, the carbohydrate content of biscuit decrease as proportion of defatted kernel flours increased in the flour blends. This may be due to the higher carbohydrate content of wheat flour compared to defatted kernel flours. [**38**, **39**]**,** supported such trend previously.

Table (3): Chemical composition of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Treatments	Moisture %	protein %*	fat %*	Crude fiber %*	Ash% *	Carbohydrate% **
Control	3.20±0.23^{g}	6.31±0.26^{i}	15.46±0.07^{g}	0.64±0.00^{i}	1.25±0.01^{f}	76.33±0.28^{a}
WF-DAKF5	3.31±0.01^{ef}	11.43±0.16^{e}	15.64±0.01^{e}	0.75±0.01^{h}	1.28±0.01^{e}	70.88±0.15^{f}
WF-DAKF10	3.42±0.02^{c}	15.74±0.29^{c}	15.80±0.01^{c}	0.96±0.01^{d}	1.31±0.00^{cd}	66.17±0.28^{h}
WF-DAKF15	3.52±0.01^{a}	19.82±0.27^{a}	15.95±0.05^{a}	1.23±0.02^{b}	1.35±0.01^{b}	61.64±0.24^{j}
WF-DPKF5	3.33±0.01^{e}	10.60±0.25^{f}	15.59±0.01^{e}	0.79±0.01^{g}	1.30±0.00^{cd}	71.70±0.22^{e}
WF-DPKF10	3.44±0.01^{c}	14.38±0.24^{d}	15.73±0.01^{d}	1.06±0.02^{c}	1.34±0.00^{b}	67.47±0.22^{g}
WF-DPKF15	3.55±0.01^{a}	17.55±0.15^{b}	15.87±0.01^{b}	1.31±0.01^{a}	1.39±0.01^{a}	63.86±0.13^{i}
WF-DMKF5	3.29±0.03^{f}	6.81±0.08^{j}	15.52±0.02^{f}	0.72±0.01^{j}	1.27±0.00^{e}	75.66±0.07^{b}
WF-DMKF10	3.38±0.01^{d}	7.30±0.08^{h}	15.62±0.01^{e}	0.82±0.01^{f}	1.30±0.01^{d}	74.95±0.09^{c}
WF-DMKF15	3.47±0.00^{b}	7.75±0.09^{g}	15.74±0.02^{d}	0.89±0.01^{e}	1.32±0.00^{c}	74.29±0.07^{d}

Control (100% wheat flour 72% extraction).
WF-DAKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted apricot kernel flour.
WF-DPKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted peach kernel flour.
WF-DMKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted mango kernel flour.
Values are the mean of triplicate determinations with standard division.
The different letters at the column means significant differences at ($p \leq 0.05$) and the same letters means no significant differences.
* Determined on dry weight basis.
**Carbohydrates were calculated by difference.

Physical characteristics of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Effect of substitution wheat flour with different levels of defatted kernel flours on diameter, thickness, spread ratio and spread factor of biscuits baked from wheat-defatted apricot, peach and mango kernel composite flours are presented in Table (4).

The results showed that all selected defatted kernel composite flour treatments caused significant ($p \leq 0.05$) decrease in biscuit diameter as compared with (4.77cm) for control except biscuit baked from 95% wheat flour and 5% defatted apricot kernel flour (WF-DAKF5) and biscuit baked from 95% wheat flour and 5% defatted peach kernel flour (WF-DPKF5). The highest diameter (4.75cm) was recorded for WF-DPKF5, while the lowest diameter (4.53cm) was found in WF-DAKF15 biscuit. [**37**] reported similar findings previously.

It was also clear that using defatted kernel composite flours at all levels in biscuit preparations resulted in significant increase in thickness when compared with 0.76cm for control. The higher thickness (0.94cm) was recorded by WF-DMKF15 biscuit sample. These results are in good agreement with [**11**].

Concerning to spread ratio, it was observed that replacing of 5% wheat flour by DPKF % recorded the highest value 5.94 followed by 5.84 for DAKF at 5%, which had significant difference with control 6.22. In addition, spread factor decreased significantly at all levels in biscuit preparations compared with control.

Table (4): Physical characteristics of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Treatment	Diameter (cm)	Thickness (cm)	Spread ratio	Spread factor
Control	4.77±0.02[a]	0.76±0.02[f]	6.22±0.19[a]	100±00[a]
WF-DAKF5	4.73±0.01[abc]	0.81±0.03[e]	5.84±0.25[b]	93.94±3.50[bc]
WF-DAKF10	4.65±0.00[de]	0.87±0.00[cd]	5.33±0.05[de]	85.69±1.91[def]
WF-DAKF15	4.53±0.01[g]	0.92±0.00[ab]	4.93±0.01[g]	79.27±2.50[g]
WF-DPKF5	4.75±0.02[ab]	0.80±0.02[e]	5.94±0.17[b]	94.46±4.79[b]
WF-DPKF10	4.68±0.02[cd]	0.84±0.02[d]	5.55±0.14[cd]	88.73±4.29[cde]
WF-DPKF15	4.55±0.00[fg]	0.90±0.02[b]	5.02±0.10[fg]	80.36±4.13[fg]
WF-DMKF5	4.71±0.05[bc]	0.84±0.01[d]	5.57±0.16[c]	89.69±1.95[bcd]
WF-DMKF10	4.67±0.05[cd]	0.90±0.02[bc]	5.19±0.13[ef]	83.58±4.58[efg]
WF-DMKF15	4.60±0.05[ef]	0.94±0.01[a]	4.89±0.13[g]	78.79±4.40[g]

Control (100% wheat flour 72% extraction).
WF-DAKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted apricot kernel flour.
WF-DPKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted peach kernel flour.
WF-DMKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted mango kernel flour.
Values are the mean of triplicate determinations with standard division.
The different letters at the column means significant differences at ($p \leq 0.05$) and the same letters means no significant differences.

Sensory evaluation of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

The data given in Table (5) and Fig (1) recorded the results of the sensory evaluation of biscuits baked from wheat flour and wheat-defatted apricot, peach and mango kernel composite flours. The results indicated that as the defatted kernel flours proportion in composite flour increased, decreased the acceptability for most sensory characteristics of biscuits. Color is an important quality indicator of a food system that could affect consumer acceptance. The color of biscuits baked from wheat-defatted apricot and peach kernel composite flours were shown not significantly different ($p \leq 0.05$) up to 10% as compared to the control. Generally, the color of biscuits made from wheat-mango kernel composite flours gave lesser score than that of biscuits as the control. These results are in good agreement with [**6**, **35**, **40**].

Data revealed that, texture of biscuits was increased from to 8.80 to 9.00 with the increase in substitution of defatted apricot and peach kernel composite flours from 0 to 15% to the biscuits. While, texture of biscuits made from wheat-mango kernel composite flours was decreased significantly ($P \leq 0.05$) with increment the substituting compared with control. The highest texture score (9.00) was recorded for WF-DPKF15, while the lowest texture score (7.10) was found in WF-DMKF15 biscuit.

Taste is the primary factor, which determines the acceptability of any product, which has the highest impact as far as market success of product, is concerned. The results showed that all selected defatted kernel composite flour treatments caused significant decrease ($p \leq 0.05$) in biscuit taste score as compared with (8.76) for control except biscuit baked from 95% wheat flour and 5% defatted apricot kernel flour (WF-DAKF5) which it not significant decrease compared with control . The highest taste score (8.60) was recorded for WF-DAKF5, while the lowest taste score (7.10) was found in WF-DMKF15 biscuit. Likewise, biscuits had lower sensory scores for odor when defatted kernel composite flours addition level was increased. Control and 5% DAKF added biscuit had the highest score for odor whereas the difference was not significant ($p<0.05$).

Overall acceptability includes many implications, which is the important parameter in organoleptic estimation. The overall acceptance expresses how the consumers or panelists accept the product generally [**41**]. As accepted, wheat biscuit has the highest overall acceptance score followed by biscuits from WF-DAKF5, WF-DPKF5 and WF-DMKF5. The lowest overall acceptance score was for biscuit from WF-DMKF15. Similar results have been previously reported by [**6**, **29**, **37**, **42**].

Table (5): Sensory evaluation of biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Treatments	color	texture	taste	odor	Overall acceptability
Control	8.89 ±0.17^{a}	8.80 ±0.27^{ab}	8.76 ±0.33^{a}	8.60 ±0.22^{a}	8.90 ±0.22^{a}
WF-DAKF5	8.75 ±0.25^{ab}	8.86 ±0.31^{ab}	8.60 ±0.22^{ab}	8.30 ±0.44 ^{ab}	8.51 ±.00^{b}
WF-DAKF10	8.58 ±0.23^{ab}	8.90 ±0.41^{ab}	8.31± 0.27^{bc}	7.90 ±0.41^{bcd}	7.91 ±0.41^{cd}
WF-DAKF15	8.31 ±0.27^{b}	8.94 ±0.43^{ab}	7.90 ±0.22^{cde}	7.31 ±0.27^{ef}	7.40 ±0.41^{efg}
WF-DPKF5	8.63 ±0.41^{ab}	8.89 ±0.54^{ab}	8.30 ±0.27^{bc}	8.10 ±0.22^{bc}	8.31 ±0.27^{bc}
WF-DPKF10	8.39 ±0.22^{ab}	8.94 ±0.51^{ab}	7.81 ±0.44^{de}	7.70 ±0.27^{cde}	7.70 ±0.27^{de}
WF-DPKF15	7.70 ±0.27^{c}	9.00 ±0.35^{a}	7.20 ± 0.27^{f}	7.00 ±0.35^{f}	7.20 ±0.25^{fg}
WF-DMKF5	8.30 ±0.75^{b}	8.29 ±0.75^{b}	8.20 ±0.44^{bcd}	8.00 ±0.00^{bc}	8.20 ±0.27^{bc}
WF-DMKF10	7.66 ±0.47^{c}	7.51 ±0.50^{c}	7.71± 0.27^{e}	7.50 ±0.35^{de}	7.52 ±0.35^{def}
WF-DMKF15	6.76 ±0.25^{d}	7.10 ±0.22^{c}	7.10 ±0.22^{f}	6.90±0.41^{f}	7.00 ±0.35^{g}

Control (100% wheat flour 72% extraction).
WF-DAKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted apricot kernel flour.
WF-DPKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted peach kernel flour.
WF-DMKF 5, 10 and 15% composite flours with 5, 10 and 15% defatted mango kernel flour.
Values are the mean of triplicate determinations with standard division.
The different letters at the column means significant differences at (p≤0.05) and the same letters means no significant difference.

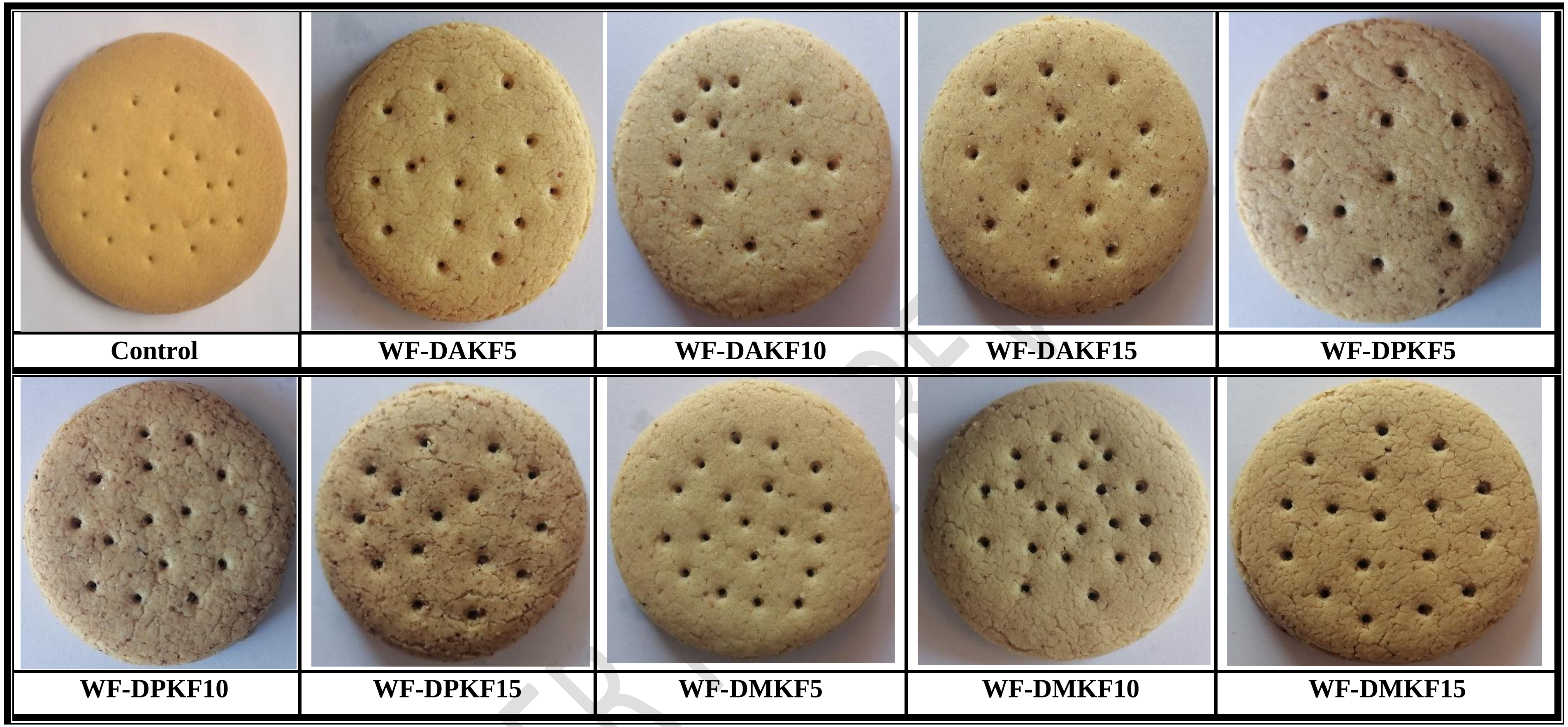

Fig (1): biscuit prepared from wheat flour substituted with defatted fruit kernel flours

Conclusion

The present study indicated that apricot, peach and mango kernel meals can be considered a good source of nutrients after removal antinutritional factors. The obtained results indicated that partially substituting DAKF, DPKF, and DMKF for WF resulted in enriched biscuits in protein, fat, ash, dietary fiber, and low carbohydrate content. Apricot, peach, and mango kernels are by-products that have exciting new potential as a food ingredient, allowing for the enrichment of biscuits and the expansion of the food base for consumers.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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