PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF COOKIES AMENDED WITH KIWI FRUIT POWDER

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Abstract

There is an increasing interest to find new sources of specific bioactive constituents that may add new healthy properties to the products. In the present study, cookies were prepared by substitution of wheat flour with different levels (0, 5, 10, 15 and 20%) of kiwi fruit edible portion (KFEP) or peels powder (KFPP). Physicochemical properties, antioxidant activity and sensory characteristics of produced cookies were evaluated. Results revealed that ash and fiber contents of produced cookies increased significantly with increasing the substitution level of KFEP or KFPP. Bioactive compounds (phenols, flavonoids and tannins) content of produced cookies were increased gradually with increasing the level of substitution. All substituted cookies showed higher antioxidant activity compared to control. A significant decrease in spread ratio of the produced cookies was occurred compared to control. Concerning cookies color, as the percentage of substitution increased, the color of the cookies became darker. Substitution with either KFEP or KFPP improved the odor character of cookies. High acceptability score was observed in substituted cookies up to 15% KFEP and 10% KFPP substitution level. The results could be useful in improving cookies quality and nutritive value.

Key words: Kiwi fruit, Cookies, Physicochemical properties, Antioxidant activity, Sensory evaluation.

INTRODUCTION

Cookies are considered to be one of the largest category of snack items throughout the world. Cookies belong to food products which are very popular in the daily diet of almost all profiles of consumers (Nassar *et al.,* 2008).

Among the bakery products, cookies are one of the most commonly used products in the incorporation of different ingredients for their nutritional diversification. This is mainly due to factors such as ease of use, good nutritional quality, availability of different varieties and affordable cost (Assis *et al.*, 2009).

Kiwi fruit is a subtropical fruit that belongs to the family Actinidiaceae and has rapidly spread from China to other parts of the world due to its easy adaptability to local climatic conditions. The fruit has a unique flavor, and today is a commercial crop in several countries, mainly in Italy, New Zealand and Brazil. This fruit consists of a hairy, brown peel containing green flesh, with white pulp in the center, surrounded by black, edible seeds (Haggag, 2013). It is considered as one of the best fruits due to its high nutritive values rich in fibers and antioxidant, that turn it into an excellent nutritional option, with an important association between quality attributes and flavor, with great acceptance in consuming markets, mainly among children (Burdon *et al.*, 2014).

Fruit peels have been a valuable source for maintaining human health. The kiwi fruit peels contain much higher beneficial compounds that possessed antioxidant capacities compared to other fruit parts (Soquetta *et al.* 2016). Fruit residues can be important sources of nutrients and to satisfy consumer demand for healthier products. Many food industries are finding ways to add functional ingredients to their products. Flour prepared from fruit shell can be used in the enrichment of products such as breads and cookies improving their nutritional and technological qualities (Assis et al., 2009).

Today, foods are not only prepared to satisfy hunger and to provide necessary nutrients for humans, but also to prevent nutrition-related diseases and improve physical and mental well-being. Therefore, the aim of the current study was to produce cookies substituted with kiwi fruit (edible portion and peels) powder at various levels and evaluate their physicochemical and sensorial properties.

MATERIALS AND METHODS

Materials

Full ripened fresh kiwi fruit (*Actinidia deliciosa*) was obtained from the local market. Baking ingredients (Sugar, baking powder, butter and sodium chloride) were purchased from local market. Wheat flour (72% extraction) was obtained from South Cairo Company of milling. 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2′-azinobis-(3-ethylbenzotiazoline-6-sulphonic acid) (ABTS), Gallic acid, Quercitin, Catechin, Phenolic acid and flavonoid standards were purchased from Sigma/Aldrich Chemical Company, USA. Folin-Ciocalteu reagent was obtained from LOBA Chemie, India. All other chemicals were of the analytical reagent grade.

Methods

Preparation of kiwi fruit (edible portion and peels) powder

The kiwi fruit was peeled manually and the edible portion of kiwi fruit (green flesh, with white pulp and black edible seeds) was sliced into thin slices. Edible portion slices and the peels of kiwi fruit were dried with oven dryer at 55 °C (for approximately 16-18 h) till its moisture content reached to ≤ 10 %. The dried edible portion (KFEP) slices and peels (KFPP) of kiwi fruit were ground into fine powder with an electric mill (Moulinex, MC3001), then packed into polyethylene bags and kept at – 20 °C for further analyses.

Preparation of cookies

Cookies samples were prepared according to the modified method of Sukhcharn *et al.* (2008). The formula used for cookies preparation [wheat flour and different proportion of kiwi fruit edible portion (KFEP) or peels powder (KFPP)] is presented in Table (1). The dough was made from 35g sugar, 40g butter, 0.5g sodium chloride, 0.6g baking powder and water using Moulinex mixer (model Supermix 150). Butter and sugar were creamed in a mixer for 2min at slow speed. Wheat flour containing various proportions of KFEP or KFPP, with baking powder was added and mixed for 3 min at medium speed. The cookies dough was sheeted, cut and baked at 170-180°C for 20 min. The baked cookies were cooled at room temperature before analyses.

Table 1. Formula of cookies substituted with powder of kiwi fruit edible portion (KFEP) or peels (KFPP)

Blends / Ingredients (g)	Control	5%	10%	15%	20%
WF	100	95	90	85	80
KFEP or KFPP	-	5	10	15	20
Sugar	35	35	35	35	35
Butter	40	40	40	40	40
Sodium chloride	0.5	0.5	0.5	0.5	0.5
Baking powder	0.6	0.6	0.6	0.6	0.6
Water	as required	as required	as required	as required	as required

WF: Wheat flour, KFEP: Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder.

Chemical analysis

Chemical composition of raw materials and cookies including the contents of moisture, ash, protein, fat and fiber were determined according to AOAC (2005). Carbohydrates were calculated by difference. Reducing and non-reducing sugars content were determined according to the method of AOAC (2005).

Bioactive compounds

The total phenol content was estimated using the method of Folin-Ciocalteau according to Singleton *et al.* (1999). Gallic acid was chosen as a standard to prepare the standard curve. Total flavonoid content was determined according to the methods of Zhishen *et al.* (1999). Quercitin was used as standard compound. Tannins were determined as described by Price *et al.* (1978). Catechin was used to prepare the standard curve.

Identification of phenolic acids and flavonoids compounds

Phenolic and flavonoid compounds were fractionated using HPLC according to the method of Goupy *et al.* (1999) and Mattila *et al.* (2000). The methanol extract of KFEP and KFPP was injected into HPLC (Agilent Series 1200). The column [Agilent 5HC-C18 (2) 250 x 4.6 mm] temperature was maintained at 35°C. Gradient separation was carried out with methanol and acetonitrile as a mobile phase at flow rate of 1 ml/min. Samples were identified against standard solutions of different phenolic and flavonoid compounds concentration by ultraviolet detector set at 280 nm for phenolic acids and 330 nm for flavonoids.

Antioxidant activity

Antioxidant activity was determined by two complementary assays. (1) Determination of Antioxidant Activity Using 2,2-diphenyl-1-picrylhydrazyl (DPPH) according to Brand-Williams *et al.* (1995). 2,2-diphenyl-1-picrylhydrazyl method (DPPH) solution (3.9 ml, 25 mg/l) in methanol was mixed with the methanol samples extract (0.1 ml). The reaction progress was monitored at 515 nm until the absorbance was stable. (2) The ABTS assay was carried out according to Re *et al.* (1999). 2, 20-Azino-bis (3-ethyl-benzothiazoline-6- sulfonic acid) diammonium salt (ABTS_+) was generated by the interaction of ABTS (7 mM) and $K_2S_2O_8$ (2.45 mM). An aliquot of 980 µl of the diluted radical transferred to cuvette, and 20 µl of methanol samples extract was added, homogenizing and agitating for a few seconds. The absorbance was measured at 734 nm

Physical properties of cookies

The diameter (D) and thickness (T) of the cookies were determined using the method of Gaines (1991). Diameter and thickness of cookies were measured by a Vernier caliper. The spread ratio (SR) was calculated by dividing diameter out of thickness. Cookies hardness was measured as described by Bourn (2003) using a Texture Analyser, Brookfield Engineering Lab. Inc., Middleboro, MA 02346-1031, USA. A 25-mm diameter cylindrical probe was used in a TPA at 2 mms^{-1} speed. Hardness was calculated from TPA graphic in Newton (N))

Water absorption capacity (WAC) and oil absorption capacity (OAC)

Water absorption capacity (WAC) and oil absorption capacity (OAC) of kiwi fruit edible portion powder (KFEP), Kiwi fruit peels powder (KFPP), wheat flour (72% extraction) and substituted blends were determined according to AACC (2000).

Water activity (a_w)

Water activity (a_w) of cookies was measured with a Rotronic Hygro Lab EA10-SCS (Switzerland) a_w meter.

Color measurement

Color of cookies was measured according to the method outlined by McGurie (1992) using a hand-held Chromameter (model CR-400, Konica Minolta, Japan). The results were expressed in terms of: *L* (lightness), *a* (redness-greenness), and *b* (yellowness -blueness).

Sensory evaluation

Sensory evaluation of samples was conducted according to Meilgaard *et al.* (2006). A 9-point hedonic scale was used for determining the sensory characteristics of cookies for appearance, odor, taste, texture and overall acceptability. The evaluation was carried out by ten panelists from the staff of Food Technology Research Institute, Agricultural Research Center, Giza- Egypt.

Statistical Analysis

The obtained data were exposed to analysis of variance ANOVA. Duncan's multiple range test at 5% level was used to compare between means (Steel and Torrie 1997).

RESULTS AND DISCUSSION

Chemical analysis and color of raw materials

Chemical composition, bioactive compounds (phenols, flavonoids and tannins) and color of wheat flour and kiwi fruit (edible portion and peels) powders are presented in Table 2. Results showed that the wheat flour was significantly lower in fiber and ash contents compared to KFEP and KFPP. Furthermore, KFPP had significantly higher fiber and ash contents (12.60 and 6.33%) than KFEP (6.78 and 4.14%). These results are in agreement with Soquetta *et al.* (2016) who reported that the flour made from kiwi fruit peels had higher ash and fiber content than edible parts. Moreover, higher content of protein and carbohydrates was significantly observed in wheat flour compared to both KFEP and KFPP. The highest fat content was found in KFEP relative to other raw materials. Regarding the total soluble sugar and reducing sugar contents, the higher values were found in KFEP (52.78and 49.68 %), respectively than those obtained from KFPP and wheat flour. From the same Table, results revealed that KFPP had significantly higher bioactive compounds (phenols, flavonoids and tannins) content followed by KFEP. Exotic fruits, especially kiwi fruit have high nutritional and bioactive properties due to their composition. Furthermore, the natural bioactive compounds in fruits such as flavonoids and phenolic acids are originally found in the peels with higher concentration towards the flesh (Leontowicz et al., 2016).

In addition, color results showed that KFEP and KFPP were darker than wheat flour, meanwhile, higher values of *a* and *b* were observed than wheat flour, it could be attributed to bioactive compounds of kiwi fruit (edible portion and peels) powder.

Table 2. Chemical composition, bioactive compounds and color of wheat flour and kiwi fruit (edible portion and peels) powder.

Constituents	WF	KFEP	KFPP
Protein%	10.83±0.30[a]	5.39 ± 0.06[b]	3.81±0.09[c]
Ash%	0.56±0.04[c]	4.14 ± 0.05[b]	6.33±0.14[a]
Fiber%	0.42±0.03[c]	6.78 ± 0.01[b]	12.60±0.14[a]
Fat %	1.02±0.10[c]	3.26 ± 0.04[a]	1.88±0.06[b]
Carbohydrates%	87.17±0.27[a]	80.43±0.24[b]	75.38±0.07[c]
Reducing sugars %	0.40±0.06[c]	49.68±0.39[a]	16.56±0.90[b]
Non reducing sugars%	1.20±0.13[c]	2.68±0.13[b]	7.46±0.67[a]
Total soluble sugar%	1.60±0.08[c]	52.78±59[a]	24.02±0.33[b]
Total phenol (mg100g^{-1})	76.55±0.47[c]	753.11±4.09[b]	1241±7.07[a]
Flavonoids (mg100g^{-1})	14.54±2.74[c]	52.81±4.84[b]	135.00±0.68[a]
Tannins (mg100g^{-1})	13.08±1.20[c]	187.65±1.64[b]	649.50±6.36[a]
L	90.57±0.04[a]	54.94±0.08[b]	54.75±0.26[b]
a	-0.58±0.06[b]	2.15±0.12[a]	2.49±0.19[a]
b	9.36±0.18[c]	21.14±0.62[b]	23.49±0.04[a]

WF: Wheat flour , KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder. Values are means of three replicates ±SD, numbers in the same raw, followed by the same letters, are not significantly different at 0.05 level.

The identification of phenolic and flavonoid compounds is considered to be an excellent tool to obtain more information about the bioactive compounds of kiwi fruit (edible portion and peels) powder. Table 3 shows the phenolic and flavonoid compounds (mg kg^{-1} DW) of KFEP and KFPP.

Table 3. Phenolic and flavonoid compounds (mg kg^{-1} DW) of KFEP and KFPP

Phenolic compounds			Flavonoid compounds		
	KFEP	KFPP		KFEP	KFPP
Gallic	8.08	9.50	Rutin	41.88	59.887
Pyrogallic	241.54	388.32	Quercetin	1.79	6.08
Catechol	38.19	111.06	Rhhomnetin	0.97	1.48
Caffeic acid	4.70	16.83	Quercetrin	24.13	39.84
Vanillic	172.95	377.49	Naringenin	1.75	2.65
Caffeine	18.29	30.77	Kaempferol	0.74	2.77
Ellagic	9.05	17.37	Apignenin	0.45	3.50
Coumarin	8.42	7.30	Luteolin	21.76	28.52
Ferulic acid	6.52	12.49	Naringin	23.31	41.65
P-Coumaric	4.18	6.74	Hespiridin	-	-
Chlorogenic	29.80	44.11	Hespirtin	9.46	16.93
Protocatechuic acid	66.98	134.49	Rosmarinic	0.40	1.16
p-Hydroxybenzoic acid	43.39	65.18			
Salysilic	18.74	5.89			
Cinnamic	0.58	0.88			

KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder.

Data in Table 3 showed that the abundant phenolic compound of both KFEP and KFPP was pyrogallic followed by vanillic and protocatechuic acid. These results are in line with those obtained by Park *et al.* (2011) who reported that the kiwi fruit contained the highest levels of protocatechuic and vanillic acids. From the same Table, it could be noticed that rutin was the major flavonoid of KFEP and KFPP followed by naringin and quercetrin. Shehata and Soltan (2013) stated that kiwi fruit contained narengnin and rosmarinic.

Chemical composition of cookies

Proximate composition and bioactive compounds of cookies are presented in Table 4. Results indicated that the substituted cookies had significantly higher content of fiber and ash than control. Ash and fiber contents increased in cookies as increasing levels of substitution and this may be attributed to the higher fiber and ash contents of the KFEP and KFPP. Cookies substituted with 20 % KFPP had significantly the highest value of ash and fiber contents. In contrast, crude protein content of cookies decreased by increasing the substitution levels relative to control. Moreover, there was no significant difference in fat content between control and substituted cookies. At the same time, slight decrease in carbohydrates content of substituted cookies was observed compared to control. Results obtained from the present study showed similar trend with those reported by Hashem *et al.* (2013) who reported that cookies prepared from wheat flour and dried kiwi fruit had significantly higher ash and fiber contents but lower carbohydrates than the control.

From the same Table, results indicated that the substitution with either KFEP or KFPP gradually increased the bioactive compounds content in cookies as compared to control. Cookies substituted with 20 % KFPP had the highest values of phenols, flavonoids and tannins content (166.08, 26.17and 77.76 mg100g^{-1}), respectively . This could be due to the higher amount bioactive compounds of KFEP and KFPP as shown in Table 2.

Table 4. Proximate composition and bioactive compounds (phenols, flavonoids, tannins) in cookies.

Samples	Protein	Ash	Fat	Fiber	Carbohydrates	Phenols	Flavonoids	Tannins
Control	8.17± 0.02^{a}	0.65± 0.01^{f}	22.35± 0.04^{b}	0.28± 0.02^{f}	68.55± 0.15^{a}	42.69± 0.52^{g}	11.83± 0.22^{g}	11.54± 0.23^{h}
5% KFEP	7.89± 0.04^{b}	0.73± 0.02^{e}	22.42± 0.07^{ab}	0.45± 0.00^{e}	68.52 ± 0.03^{a}	62.09± 0.75^{f}	13.10± 0.18^{f}	16.12± 0.15^{g}
10%KFEP	7.61± 0.05^{c}	0.82± 0.02^{d}	22.53± 0.08^{ab}	0.66± 0.04^{d}	68.38± 0.11^{ab}	87.86± 2.79^{d}	14.44± 0.22^{e}	19.70± 0.93^{f}
15%KFEP	7.33± 0.05^{d}	0.98± 0.01^{c}	22.58± 0.04^{ab}	0.82± 0.03^{c}	68.29± 0.19^{ab}	107.8± 2.79^{c}	16.45± 0.52^{d}	26.96± 0.84^{e}
20%KFEP	7.08± 0.05^{e}	1.12± 0.03^{b}	22.67± 0.01^{a}	1.12± 0.05^{b}	68.02± 0.14^{bc}	126.1± 5.56d^{b}	17.96± 0.91^{c}	31.93± 1.14^{d}
5%KFPP	7.84± 0.04^{b}	0.84± 0.02^{d}	22.39± 0.01^{b}	0.59± 0.01^{d}	68.34± 0.20^{ab}	72.96± 1.59^{e}	15.43± 0.31^{de}	27.47± 1.55^{e}
10%KFPP	7.52± 0.10^{c}	1.00± 0.03^{c}	22.43± 0.03^{ab}	0.90± 0.06^{c}	68.14± 0.23^{abc}	106.75± 1.24^{c}	18.96± 0.36^{c}	45.43± 1.85^{c}
15%KFPP	7.17± 0.04^{e}	1.15± 0.04^{b}	22.50± 0.07^{ab}	1.10± 0.03^{b}	68.08± 0.14^{bc}	132.55± 5.03^{b}	21.89± 0.27^{b}	65.13± 1.45^{b}
20%KFPP	6.90± 0.04^{f}	1.29± 0.01^{a}	22.53± 0.08^{ab}	1.49± 0.07^{a}	67.79± 0.22^{c}	166.08± 8.69^{a}	26.17± 0.66^{a}	77.76± 0.81^{a}

KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder. Values are means of three replicates ±SD, numbers in the same column, followed by the same letters, are not significantly different at 0.05 level

Antioxidant activity

There are some reports that indicate an improvement in the antioxidant potential of the cookies incorporated with natural plant fibers. Therefore, their antioxidant activity was assessed using DPPH and ABTS scavenging activity methods of the investigated samples. Antioxidant activity of methanol extract of KFEP, KFPP as well as cookies are illustrated in Fig.1. Data revealed that methanol extract of both KFEP and KFPP had the highest DPPH and ABTS scavenging activity and the higher antioxidant activity was observed in methanol extract of KFPP. Soquetta *et al.* (2016) reported that the flour made with kiwi fruit peels showed higher levels of bioactive compounds and antioxidant activity than flour made with other kiwi fruit parts. From the same figure, it could be noticed that increasing the level of either KFEP or KFPP progressively increased the antioxidant activity of cookies. This is attributed to high bioactive compounds content of the KFEP and KFPP as compared to wheat flour.

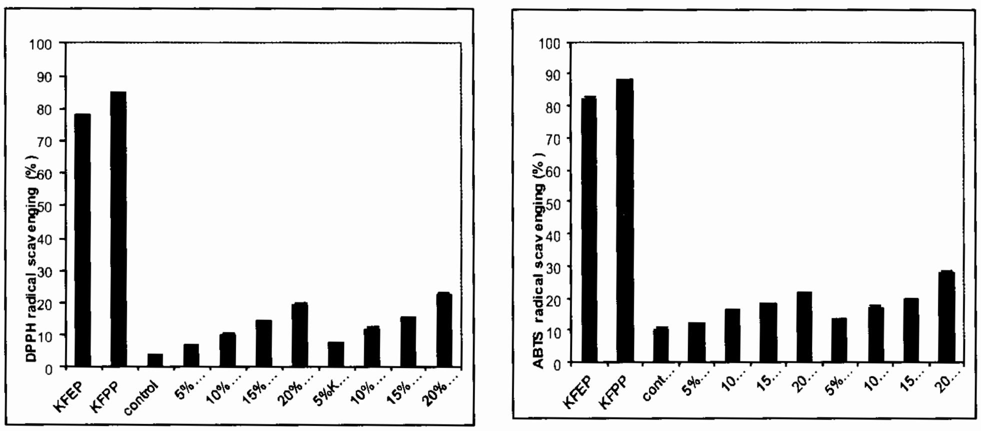

Fig.1. DPPH and ABTS scavenging activity of KFEP, KFPP and produced cookies
KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder. Values are means of three replicates ±SD

Water and oil absorption capacity

Water and oil absorption activity (WAC and OAC) of raw materials and their blends are illustrated in Fig.2.

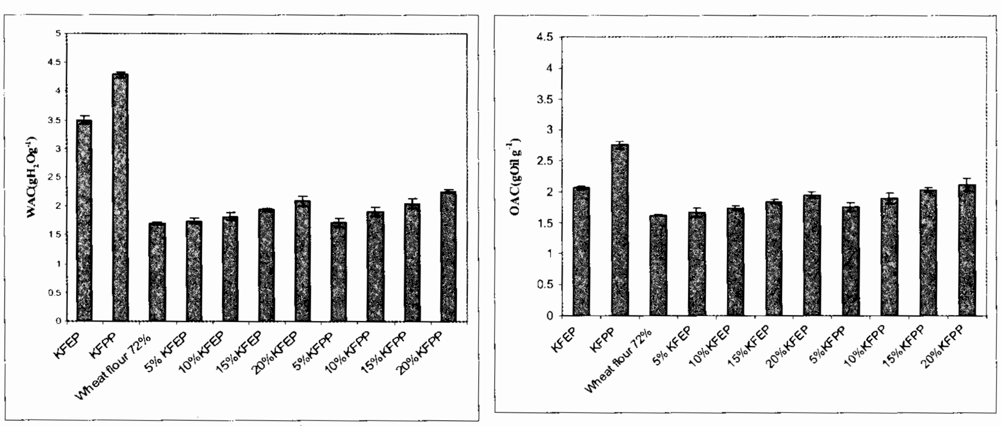

Fig.2. Water and oil absorption activity (WAC and OAC) of raw materials and blends
KFEP : (Kiwi fruit edible portion powder), KFPP: Kiwi fruit peel powder.

Data in Fig. 2 showed that the KFEP and KFPP had the higher WAC (3.50 and 4.24 gH_2Og^{-1}) compared to wheat flour (1.69 gH_2Og^{-1}). Furthermore, water absorption capacity increased in blends by increasing the level of substitution. These results could be attributed to higher fiber content of KFEP and KFPP. Moreover, blends containing KFPP had higher WAC than blends containing KFPP. Sharma *et al.* (2013) reported that the greater number of hydroxyl groups existing in the fiber structures allows more water interactions through hydrogen bonding. Results cleared that KFPP had higher OAC than KFEP and wheat flour. The OAC increased with an increase in the KFEP and KFPP percentage in the blends. The surface of a fiber normally has a high capacity to hold oil by mechanical process, thus a higher fiber content could enhance the OAC of the blends (Sharma and Gujral, 2014).

Physical properties of cookies

The physical properties of cookies such as diameter, thickness, spread ratio and hardness are presented in Table 5. Results showed that the diameter was slightly decreased with increasing the substitution level. While, there was a significant difference in thickness between control and cookies substituted with KFEP and KFPP, This difference in the thickness is reflected in spread ratio of control as well as substituted cookies. The spread ratio is another important characteristic in determining the quality of the cookies. Results in Table 5 indicated that the substitution of wheat flour with KFEP or KFPP in cookies reduced the spread ratio. The higher absorption capacity of the KFEP or KFPP during the dough mixing resulted in a reduction of the spread ratio. McWatters *et al.* (2003) proposed that the mechanism relating to the reduction of the spread ratio was affected by the replacement of wheat flour with fiber. During mixing, a rapid partitioning of free water to hydrophilic sites took place, resulting in an increase in the dough viscosity. This led to a limitation of the cookie spread. The reduced spread ratio has also been reported of cookies made from wheat flour substituted with fiber rich sources such as watermelon rind (Naknaen *et al.,* 2016).

Table 5. Physical properties of cookies

Samples	Diameter (mm)	Thickness (mm)	Spread ratio	Hardness (N)
Control	39.78± 0.87^{a}	6.85 ±0.07^{e}	5.81±0.09^{a}	14.48±0.74^{a}
5% KFEP	39.72±0.84^{a}	6.99 ±0.15^{de}	5.68±0.14^{ab}	14.06 ±1.05^{ab}
10%KFEP	39.49±0.21^{a}	7.15± 0.07^{cd}	5.52±0.08^{bc}	13.61± 0.64^{ab}
15%KFEP	39.25±0.77^{a}	7.31± 0.07^{c}	5.37±0.04^{c}	13.13±0.38^{abc}
20%KFEP	39.14 ±0.51^{a}	7.63±0.15^{ab}	5.12± 0.12^{de}	12.45 ± 0.77^{bc}
5%KFPP	39.52± 0.22^{a}	7.17 ±0.07^{cd}	5.51±0.02^{bc}	13.80± 0.28^{ab}
10%KFPP	39.28 ± 0.20^{a}	7.40±0.14^{bc}	5.31 ±0.13^{cd}	13.06 ±1.1^{abc}
15%KFPP	39.00± 0.71^{a}	7.68±0.11^{a}	5.08 ± 0.09^{e}	12.56±0.79^{bc}
20%KFPP	38.71± 0.55^{a}	7.84± 0.08^{a}	4.94± 0.07^{e}	11.69 ±0.72^{c}

KFEP : (Kiwi fruit edible portion powder), KFPP: Kiwi fruit peels powder. Values are means of three replicates ±SD, numbers in the same column, followed by the same letters, are not significantly different at 0.05 level

Texture is one of the most important parameter which determines the consumer acceptability of foods. Instrumentally measured, the hardness of cookies was expressed as a maximum force necessary to break them. Hardness of cookies is presented in Table 5. Results showed that hardness decreased non significantly of substituted cookies up to 15% KFEP and 10% KFPP substitution level. As the level of substitution of wheat flour with either KFEP or KFPP increased, the hardness tended to decrease. This data indicated that the cookies tended to become softer at the high level of substitution. Similarly, the hardness of the cookies decreased by incorporating fiber rich powders such as watermelon rind (Naknaen et al., 2016) in the formulation.

Color of cookies

Cookies color is an important characteristic for consumer preference and it depends on physicochemical parameters of used raw materials and baking. The color measurements of produced cookies are shown in Table 6. It could be observed that there was a significant decrease in *'L'* (lightness), with the steady increase in the percentage of KFEP or KFPP in the cookies. The lowest *L* value was observed in cookies substituted with 20% KFPP . The decrease in lightness could be attributed to the natural pigments of KFEP and KFPP such as polyphenols. Sharma and Gujral (2014) reported that the higher fiber addition in cake and biscuit formulation promoted severely the browning reactions as evidenced by the low *L* value.

Regarding to *a* (redness) and *b* (yellowness) values, data revealed that using KFEP and KFPP in cookies preparation resulted in significant increase in *a* and *b* values compared to control . These results may be occurred because of brown color of kiwi fruit (edible portion and peels) powder and caramelization reaction of sugar substances during cookies baking.

Table 6. Color measurements of produced cookies

Samples	*L*	*a*	*b*
Control	66.81±0.73[a]	0.37±0.02[h]	25.33±0.47[f]
5% KFEP	62.07 ±0.12[b]	1.82±0.028[g]	26.26±0.346[e]
10%KFEP	60.83±1.17[bc]	3.15±0.04[e]	27.03±0.035[d]
15%KFEP	57.41 ± 0.57[d]	3.87 ±0.07[d]	28.06±0.06[c]
20%KFEP	56.14 ± 0.19[d]	4.28±0.07[c]	29.11±0.15[b]
5%KFPP	60.04 ± 0.50[c]	2.30±0.08[f]	27.21±0.07[d]
10%KFPP	56.64± 0.51[d]	4.28±0.23[c]	28.35±0.14[c]
15%KFPP	50.94± 0.08[e]	4.99±0.127[b]	29.35±0.49[b]
20%KFPP	49.86± 0.20[e]	5.80±0.14[a]	32.29± 0.42[a]

KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder.

*L (lightness with L = 100 for lightness, and L = zero for darkness), a [(chromaticity on a green (−) to red (+)], b [(chromaticity on a blue (−) to yellow (+)], Values are means of three replicates ±SD, numbers in the same column, followed by the same letters, are not significantly different at 0.05 level.

Water activity of cookies

The measurement of water activity is important considering the development of a product, can be used for the determination of shelf-life and it is an analysis of quality control. The results obtained are illustrated in Fig.3. Increasing the substitution levels with either KFEP or KFPP in the cookies slightly increased the water activity of cookies from 0.384 to 0.429 relative to control 0.382. Water activity for substituted cookies was in safety limits for microbial safety as reported by Beuchat (1981) who mentioned there is no microbial spoilage below a_w value 0.5.

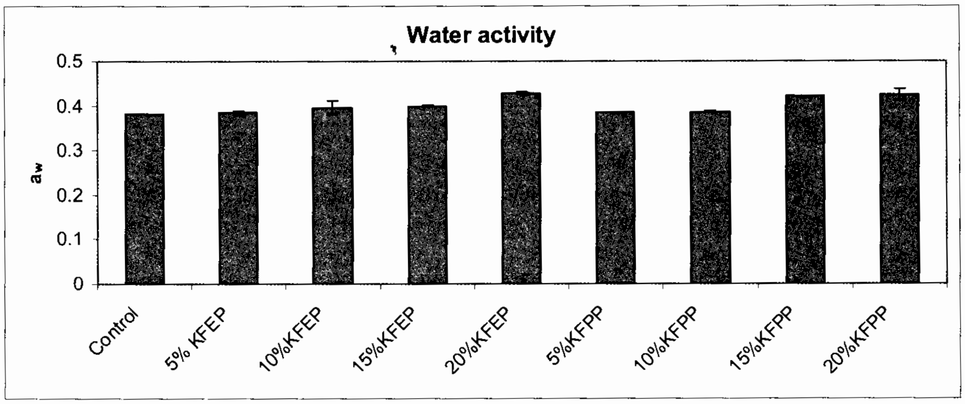

Fig. 3. Water activity of cookies

KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder. Values are means of three replicates ±SD

Sensory evaluation

Sensory evaluation of produced cookies is shown in Table 7. It was noticed that no significant differences in appearance score were found between the control sample and cookies substituted up to10% KFEP or KFPP. However, increasing the level of substitution from 15 to 20% decreased significantly the scores for appearance. This result was in accordance with the decrease in the lightness and the increase in redness values. Tabulated data indicated that the substitution with either KFEP or KFPP improved slightly odor score. Cookies substituted with 15% KFEP had the highest score for odor. This might be attributed to the higher content of volatile aromatic of kiwi fruit (Zhang et al., 2016). Regarding taste score, data revealed that substitution with KFEP did not affect significantly taste score except for substitution level at 20%. However, taste score decreased significantly at 15 and 20% KFPP substitution level. It may be related to the slight bitterness in taste due to increasing polyphenols and tannins content at the highest level of substitution. The texture slightly decreased with increase substitution levels. In addition, substituted cookies up to 15% KFEP and 10% KFPP showed no significant differences in all over all acceptability relative to control. The present obtained results are similar to that reported by Hashem *et al.* (2013) who noted that partially replacing wheat flour with dried kiwi up to 15% did affect biscuit acceptability.

Table 7. Sensory evaluation of cookies

Samples	Appearance (9)	Odor (9)	Taste (9)	Texture (9)	Overall Acceptability (9)
Control	8.94 ± 0.17^{a}	8.50 ± 0.18^{bc}	8.56 ± 0.32^{a}	8.93 ± 0.17^{a}	8.90 ± 0.17^{a}
5% KFEP	8.88 ± 0.23^{a}	8.69 ± 0.26^{ab}	8.69 ± 0.45^{a}	8.81 ± 0.37^{ab}	8.75 ± 0.37^{a}
10%KFEP	8.38 ± 0.44^{a}	8.75 ± 0.23^{ab}	8.75 ± 0.37^{a}	8.76 ± 0.26^{ab}	8.38 ± 0.64^{a}
15%KFEP	7.75 ± 0.46^{b}	8.81 ± 0.38^{a}	8.37 ± 0.27^{a}	8.44 ± 0.68^{abc}	8.19 ± 0.79^{ab}
20%KFEP	7.44 ± 0.62^{bc}	8.31 ± 0.26^{cd}	7.31 ± 0.77^{b}	8.13 ± 1.00^{bc}	7.56 ± 1.14^{bc}
5%KFPP	8.75 ± 0.37^{a}	8.73 ± 0.24^{ab}	8.63 ± 0.44^{a}	8.69 ± 0.37^{abc}	8.69 ± 0.46^{a}
10%KFPP	8.44 ± 0.62^{a}	8.63 ± 0.23^{ab}	8.25 ± 0.52^{a}	8.38 ± 0.62^{abc}	8.25 ± 0.74^{ab}
15%KFPP	7.69 ± 0.37^{b}	8.25 ± 0.38^{cd}	6.81 ± 0.53^{c}	8.19 ± 0.53^{bc}	7.00 ± 0.75^{c}
20%KFPP	7.06 ± 0.33^{c}	8.19 ± 0.37^{d}	6.00 ± 0.59^{d}	8.00 ± 0.70^{c}	6.06 ± 0.38^{d}

KFEP : Kiwi fruit edible portion powder, KFPP: Kiwi fruit peels powder. Data are presented as means ± SDM (n =10, a 9-point hedonic scale) & numbers in the same column, followed by the same letters, are not significantly different at 0.05 level.

CONCLUSION

This current study was carried out to improve cookies production by substitution with kiwi fruit (edible portion and peels) powder which was considered as a good source of phytochemicals components like crude fibers, bioactive compounds and antioxidant activity. It could be concluded that substitution of wheat flour with kiwi fruit (edible portion and peels) powder improved the antioxidant activity and nutritional quality with acceptable sensory characteristics of produced cookies at 10 and 15% substitution level of KFPP and KFEP, respectively. So, it is possible to maximize the benefit of the kiwi fruit and its peels powder as a preferred functional product for consumers, especially children who like cookies.

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الصفات الفيزيوكيماوية والحسية للكوكيز المدعم بمسحوق الكيوى

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هناك اهتمام متزايد لايجاد مصادر جديدة للمركبات النشطة حيويا والتي تضيف خصائص صحية جديدة للمنتجات. في الدراسة الحالية تم انتاج كوكيز باستبدال دقيق القمح بمستويات مختلفة (صفر،٥ ، ١٠،١٥ ، ٢٠ ٪) من مسحوق الجزء المأكول (KFEP) أوالقشور (KFPP) لثمار الكيوى .وقد تم تقييم كل من الخواص الطبيعية والكيمياوية والنشاط المضاد للتأكسد والصفات الحسية للكوكيز الناتج. وقد دلت النتائج على حدوث زيادة معنوية فى محتوى الرماد والألياف فى الكوكيز الناتج بزيادة نسبة الإستبدال بمسحوق الجزء المأكول أوقشور الكيوى. وقد وجد أيضا أن المحتوى من المركبات النشطة حيويا (فينولات، فلافونويدات، تانينات) زاد تدريجيا مع زيادة نسبة الإستبدال. وقد أظهرت عينات الكوكيز المستبدل نشاط مضاد للتأكسد عالى مقارنة بالكنترول. وأيضا حدث انخفاض معنوى فى معدل الانتشار للكوكيز الناتج مقارنة بالكنترول. كما وجد أنه بزيادة نسبة الإستبدال أصبح لون الكوكيز الناتج داكنا وأيضا الإستبدال بالجزء المأكول أو قشور الكيوى أدى إلى تحسين رائحة الكوكيز. كما لوحظ وجود نسبة قبول عالى للكوكيز المستبدل حتى نسبة إستبدال ١٥٪ من الجزء المأكول و ١٠٪من قشور الكيوى. هذه النتائج قد تساهم فى تحسين تصنيع الكوكيز و القيمة المضافة لإستخدام ثمار الكيوى وقشورها كأغذية وظيفية للمستهلك.

الكلمات الدالة: ثمار الكيوى، كوكيز، الصفات الفيزيوكيماوية، النشاط المضاد للتأكسد، التقييم الحسى.