Evaluation of Globe Artichoke By-products for Enhancing Functional Properties of Some Foods

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ABSTRACT: Proximate chemical composition, minerals content, bioactive compounds and the effect of blanching to inactivate polyphenol oxidase in globe artichoke by-products (bracts (B) and floral stem (FS) was determined. Also, some applications of these by-products were evaluated as functional food. The results of present study revealed that nitrogen free extract (NFE) was the highest component of the proximate composition and there were considerable amount of crude fiber (CF). Raw bracts (RB) and raw floral stems (RFS) had 50.34 and 55.00% NFE and 24.84 and 14.88 % CF, respectively. The values of dietary fiber fractions could be ranked in descending orders as follows: neutral detergent fiber (NDF) (46.36 and 33.24%), acid detergent fiber (ADF) (30.69 and 21.30%), cellulose (25.42 and 14.87%), hemicelluloses (15.67 and12.05%) and acid detergent lignin (ADL) (5.27 and 6.43%) for RB and RFS, respectively. Floral stem had higher inulin (7.67%) content than bracts (6.56%). Bracts and floral stems could be considered a good source of macro and micro minerals , K (3089.12 and 3152.71 mg/100g d.w, respectively) was the most abundant one among macro minerals, while Fe (14.95 and 13.87 mg/100 g d.w, respectively) was the most abundant one among the micro- minerals. Sensory evaluation revealed that artichoke by-products could be used in fortifying potato puree and biscuits since all samples were accepted by the panelists. The most acceptable samples of potato puree were that contain 5, 10 and 20% floral stem core puree. As for biscuits, the most acceptable samples were that containing 2.5, 5 and 7.5 % substitution of BFS, for biscuits containing BB was that had 2.5%.

Keywords: globe artichoke, bracts, floral stems, dietary fiber fractions inulin, minerals.

INTRODUCTION

The food industry generate large amount of wastes or by-products annually around the world from a variety of sources. In that food wastes or by-products are an excellent source of nutraceuticals, bioactives, inherently functional and possess many components that are good for human health. Food wastes or by-products convert to functional food ingredients. The waste management is one of the major parts of food industries. The large volume of the low cost by-product gives economical advantage of its potentially valuable components and environmental benefits. Therefore, the recovery of by-products to health beneficial product and economic benefit to labour, stakeholder and country (Helkar *et al*., 2016).

Globe artichoke (*Cynara cardunculus* var. *scolymus* L. Fiori) is an ancient perennial plant species (Asteraceae) native to the Mediterranean Basin and known since the first century A.D. by the ancient Grecks and Romans. The Arabs played an important role in its distribution in the Southern Mediterranean area during the Middle Ages (Sonnate *et al*., 2007). The globe artichoke distributed all over the world and especially in the South Europe (Italy, Spain, France, and Greece), Middle East (Turkey, Israel), North Africa (Egypt, Tunisia), South America (Argentina, Chile), United States and also in China (Pandino *et al*., 2013). The globe artichoke harvested area in the world is about 125351 hectares, of which about 75% are located in the Mediterranean area and, in particular, in Italy, Egypt, Spain, Argentina and Peru. The production of globe artichoke in Egypt through 2000 to 2014 was 84913 to 266196 tons. The exported amount of Globe artichoke was increased from 4234 tons in 2000 to 8900 tons in 2014 (FAO, 2014). Artichoke plays an important role in human nutrition, especially in the Mediterranean area. The ratio of edible portion / total biomass produced by the plant is very low, less than 15 – 20 % of the total plant biomass (Lattanzio *et al*., 2009). Globe artichoke is cultivated for its large immature flower heads. The edible parts are the tender inner bracts and the receptacle, commonly known as ''heart'' that constitute nearly 35–55% of the weight of the head (Ceccarelli *et al*., 2010).

Artichoke edible parts are one of the richest dietary sources of polyphenols with high bioavailability, and contain also inulin, fibres and minerals. Moreover, pharmaceutical artichoke leaf extracts show hypocholesterolemic and choleretic properties**.** The total antioxidant capacity of artichoke flower heads is one of the highest reported for vegetables, and is strictly related to their polyphenolic content (Ceccarelli *et al*., 2010). For this reason, it is considered as a functional food (Orlovskaya *et al*., 2007 and Ruiz-Cano *et al*., 2014). During the industrial processing of artichokes, about 80 - 85% of the total plant biomass is discarded. This material consists mainly of the external parts of the flowers, which are commonly known as bracts and the stems. It is unsuitable for human consumption and is usually disposed of as a solid waste (Gaafar and Salama, 2013 and Zuorro, 2014). Artichokes by-products are a potential source of dietary fiber (DF), which could be incorporated into food products as a potential functional ingredient .Typically, DF from cereals had been used in food development; however, over the past decade, high DF materials from fruits and vegetables have been utilized. The possibility of utilization of food processing by- products as a source of dietary fiber, functional or novel fiber for manufacturing various human foods has created enormous scope for waste reduction and indirect income generation (Sharma *et al*., 2016).Stems and the external parts of the flowers (bracts) which are not suitable for human consumption and could be used as a source of inulin, phenolics, and should be considered as a raw material for production food additives and nutraceuticals (Jimenez-Escrig *et al*., 2003). The present study aimed to determine the proximate composition, minerals, inulin and dietary fiber of globe artichoke by-products (bracts and floral stem) and its utilization in producing some functional foods.

MATERIALS AND METHODS

Materials:

Artichoke (*Cynara scolymus* L.) by-products originated from freezing industry (bracts and floral stems) used in this investigation were collected during the winter season of 2016 from Givrex Company, Alexandria, Egypt. **Fig. (1)** illustrates the outline of preparing globe artichoke by-products (bracts and floral stems). The plants of globe artichoke received to the company were the heads that harvested with the floral stem. All chemicals used were of analytical grade, and were purchased from El-Gamhouria Co. for chemical and medical requisites, Alexandria, Egypt. Wheat flour (extraction 72%), potato, liquid milk, sugar, shortening, butter, baking ammonia, salt, vanillin, pepper powder , glass jars and polyethylene bags used as packaging materials for the preparation and formulation of food products were purchased from local markets in Alexandria, Egypt.

Fig (1). Globe artichoke (*Cynara scolymus* L.) main product (receptacle) and by-products (bracts and floral stems)

Methods:

Technological methods:

Preparation of Artichoke (*Cynara scolymus* L.) by-products

The following methods describe the preparation of raw bracts (RB), raw floral stems (RFS), blanched bracts (BB), blanched floral stems (BFS). Fig. (2) illustrate the process of elaboration methods for preparing globe artichoke by-products to be utilized in some functional food products.

Raw and blanched bracts

Fresh artichoke bracts were washed with tap water drained and was divided into two parts. The first part was dried without blanching and the second part was blanched in boiling water for 3 min. in order to inactivate polyphenol oxidase, cooled with tap water and drained. The two parts were spreaded on aluminum trays and dried in a cabinet drier at 50℃ for two days. The dried bracts were ground to pass through 60 mesh sieve and packed in glass jars and stored at 5ºC until used.

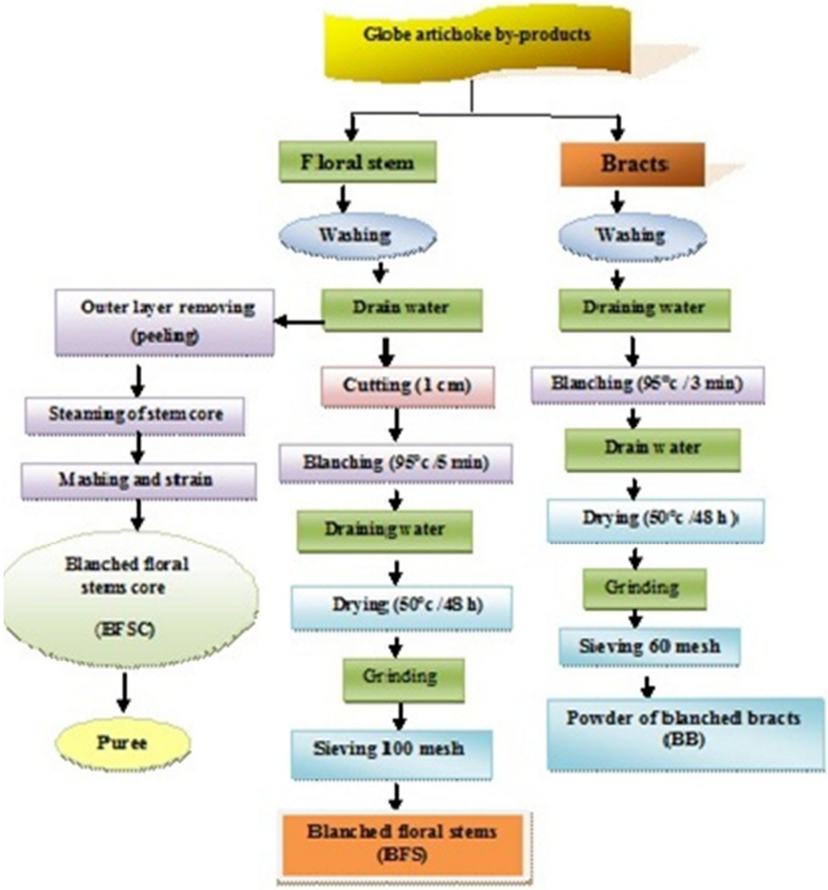

Fig. (2). Process of elaboration methods for preparing globe artichoke by-products.

Raw and blanched floral stems

Fresh artichoke floral stems were washed with tap water, sliced into small pieces (1 cm), and were divided into two parts. The first part was dried without blanching and the second part was blanched in boiling water for 5 min. in order to inactivate polyphenol oxidase, cooled with tap water and drained. The two parts were spreaded on aluminum trays and dried in a cabinet drier at 50℃ for two days. The dried stems were ground to pass through 60 mesh sieve and packed in glass jars and stored at 5ºC until used.

Blanched floral stems core (BFSC)

Fresh artichoke floral stems were washed with tap water, the outer layer of the floral stem was manually removed, and then steam blanching was used (20 min), cooled with tap, mashed and strained to obtain artichoke floral stem core puree (FSCP).

Utilization of globe artichoke by-products in some functional products:
Preparation of Biscuits:

Biscuits were prepared from blends of wheat flour containing 0, 2.5, 5, 7.5 and 10 % of BB and BFS, using the method described by Smith (1972). The formula used for preparing biscuits is shown in Table (1).

Table (1). Ingredients used for preparing biscuits containing different concentrations of globe artichoke by-products

Ingredient	control (g)	% (BB) *				% (BFS) **			
		2.5	5	7.5	10	2.5	5	7.5	10
Wheat flour	100.00	97.50	95.00	92.50	90.00	97.50	95.00	92.50	90.00
BB	-	2.50	5.00	7.50	10.00	-	-	-	-
BFS	-	-	-	-	-	2.50	5.00	7.50	10.00
Liquid milk	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Sugar	47.50	47.50	47.50	47.50	47.50	47.50	47.50	47.50	47.50
Shortening	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50
Baking ammonia	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vanillin	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

BB *: Blanched bracts. BFS **: Blanched floral stems.

Preparation of Puree:

Puree product was made from blends of mashed potato tubers containing 0, 5, 10, 20, 30 and 40 % of mashed blanched artichoke floral stem core (BFSC) as the method described by Wafaa *et al.* (2005). Liquid milk was added to the mashed blanched products (potato or globe artichoke floral stems core) .The mix was blended in presence of salt, black pepper and melted butter at the levels mentioned in Table (2).

Table (2). Ingredients used for preparing puree containing different concentration of globe artichoke by-products.

Ingredient	Control (g)	% BFSC				
		5	10	20	30	40
Potato	91.07	86.52	81.96	72.86	63.75	54.64
BFSC	-	4.55	9.11	18.21	27.32	36.43
Liquid milk	5.45	5.45	5.45	5.45	5.45	5.45
Butter	2.73	2.73	2.73	2.73	2.73	2.73
Salt	0.45	0.45	0.45	0.45	0.45	0.45
Pepper powder	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00

BFSC: Blanched floral stem core.

Biscuit characteristics:

Biscuit characteristics were evaluated according to Hooda and Jood (2005) with the following measurements: Average weight of six pieces (g), diameter of 6 pieces (mm) and thickness of 6 pieces (mm). Spread ratio was calculated by dividing the average value of diameter (mm) by the average value of thickness (mm).

Analytical methods:

Proximate composition including moisture content, crude protein, crude ether extract, crude fiber and total ash were determined according to the methods of AOAC (2007). Nitrogen free extract (NFE) was calculated by difference. Minerals were determined according to the method of (AOAC, 2007). Ca, Mg, Fe, Mn, Cu and Zn were determined by atomic absorption spectrophotometric (Perkin-Elmer Instrument Model 2380). K and Na were determined by flame photometer. Dietry fiber fractions including neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose and hemicelluloses were analyzed using the method of Goering and Van Soest (1970). Total sugar and inulin were estimated as described by Sadasivam and Manickam (1992). Reducing sugar were determined using Lane-Eynon procedure as stated in the AOAC (2007). Non-reducing sugars were calculated as following: Non-reducing sugars % = (Total sugars % - Reducing sugars %) x 0.95.

Sensory evaluations:

Colour, taste, odour, texture and overall acceptability of biscuit and puree were assessed by 10 panelists of Food Technol. Lab., Food Technol. Research Inst., Agriculture Research Center, of Sabahia, Alexandria, Egypt. The panelists were asked to score the above attributes according to a standard hedonic rating scale consisting of 9 points from 1 (Extremely dislike) to 9 (Extremely like) according to Kramer and Twigg (1970).

Statistical analysis:

the Data was subjected to statistical analysis using analysis of variance (ANOVA). The average values (mean± standard deviation) were compared by using Least Significant Differences test (LSD- test) as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

In the present study, the evaluation of nutritional value and utilization of globe artichoke by-products required to determine the proximate chemical composition, mineral content and some bioactive compounds of bracts and floral stems as main by-products in addition to estimate the weight composition of the plant head received to the factory which consists of receptacle, bracts and floral stem. The average weight of receptacle, bracts and floral stem was 73.20, 142.32 and 86.80 g which represented 24.21, 47.08 and 28.71 % of the total weight (302.32 g) of plant head, respectively. This means that, these by-products (bracts and floral stem) represent about 75.79% of the total globe artichoke weight. Schieber *et al.* (2001) and Zuorro (2014) mentioned that from the industrial processing of artichokes, large amounts of solid and liquid wastes are generated. Solid residues constitute about 80-85% of the total plant biomass and consist mainly of the stems and the external parts of the flowers, known as bracts.

Proximate chemical composition:

Proximate composition of raw and blanched globe artichoke by-products (bracts and floral stem) is represented in Table (3). RB contained : 84.51% moisture, 15.71% crude protein (CP), 1.78% crude ether extract (CE), 24.84% crude fiber (CF), 7.33% ash and 50.34% NFE, while RFS had 89.57% moisture, 17.12 % CP, 2.55 % CE, 14.88% CF, 10.45% ash and 55.00% NFE on d.w. These results indicated that RFS had higher CP, CE, ash and NFE values than RB, while RB had higher CF than RFS. The results revealed that the highest component was NFE, while crude fiber represented considerable amount, then crude protein**.** Blanching in boiling water (5min for floral stems and 3min for bracts) in order to inactivate polyphenol oxidase enzyme caused slight decrease in CP, CE, CF and ash and slight increase in NFE. The decrease in the previous mentioned component may be due to leaching out of some of the constituents into the blanching medium. Because of these decreases, the NFE was increased. Statistical analysis indicated that there were significant differences between all the components of RB and RFS proximate composition. Blanching in boiling water caused significant differences between all the component of RB and BB, also between RFS and BFS. The data in Table (3) revealed that RB had values of CP and CF very close to that recorded by Salman *et al*. (2014)for artichoke by product (16.61and 24.22 %, respectively), while CE and ash were lower than the results of the same authors (5.46% CE and 12.66 % ash). Claus *et al*. (2015) evaluated the chemical composition of bracts and observed that CP (10.35%), ash (5. 37%) and NFE (33.52%) were lower, while CF (44.23%) and CE (2.04 %) were higher than the result in Table (3).As for RFS, Sallam (2005) found ash (11.71%) CF (16.5%) and NFE (56.1%) of globe artichoke stems higher than that found in the present study, while CP (14.34%) and CE (1.35%) were lower. Boubaker *et al.* (2016) recorded lower content of CP (11.53%) and CE (0.86%), for artichoke stem powder, while ash (10.28%) content was very close.

Mineral content:

Mineral content of RB, BB, RFS and BFS are represented in Table (3).These results indicated that RB(100g d.w) had K (3089.12 mg) as the major elements followed by Ca (73.66 mg), Na (54.17 mg) and Mg(47.67 mg), then Fe (14.95 mg), while Zn (3.03 mg) , Cu (1.39 mg), Mn (0.63 mg) were found to have small values for 100g d.w. Pandino *et al.* (2011) reported that globe artichoke capitulum, including bracts, provides relevant quantities of some minerals, such as K, Ca and Fe. The results recorded here are in disagreement with Romani *et al*. (2006). Attia *et al*. (2016) found the same elements in RB except that Fe was higher than Mg; all values found by the previous authors for K, Ca, Na, Mg and Mn were lower than the results of the present study except Fe had relatively close value, while Zn and Cu had higher values. Mineral values of RFS had the same as of RB except that Na had value higher than Ca. All the determined elements of RFS had values higher than that of RB except that Fe and Cu were relatively lower. As it seen from Table (3), each 100 g d.w of RFS had 3152.71, 93.05, 87.58, 60.21, 13.87, 0.79, 4.16 and 1.36 mg for K, Na, Ca, Mg, Fe, Zn, Cu and Mn, respectively.

Table (3). Proximate chemical composition and mineral content of globe artichoke by-products (on dry weight basis)

Component (%)	Bracts		LSD	Floral Stem		LSD	LSD (RB&RFS)
	RB	BB		RFS	BFS		
Moisture	84.51^{B}±.05	ND		89.57^{A}±.03	**ND**		1.325
Crude protein (N x6.5)	15.71^{Ba} ± 0.12	15.39^{b}± 0.11	0.2666	17.12^{Aa} ± 0.04	16.89^{b}± 0.04	0.1031	0.2069
Crude ether extract	1.78^{Ba} ± 0.05	1.59^{b} ± 0.06	0.1335	2.55^{Aa} ± 0.06	2.32^{b} ± 0.05	0.1354	0.1385
Crude fiber	24.84^{Aa} ± 0.16	24.59^{a}± 0.11	0.3167	14.88^{Ba} ± 0.05	14.50^{b} ± 0.36	0.5907	0.2772
Ash	7.33^{Ba} ± 0.06	7.19^{b} ± 0.05	0.1325	10.45^{Aa} ± 0.6	10.25^{b} ± 0.06	0.1481	0.1437
Nitrogen free extract	50.34^{Bb} ± 0.13	51.24^{a}± 0.08	0.2461	55.00^{Ab} ± 0.54	56.04^{a} ± 0.07	0.8897	0.9059
Mineral content (mg/100g)							
K	3089.12	2627.02		3152.71	2841.47		
Na	54.17	41.26		93.05	76.79		
Ca	73.66	65.15		87.58	80.09		
Mg	47.67	40.17		60.21	53.76		
Fe	14.95	13.79		13.87	12.95		
Mn	0.63	0.53		0.79	0.70		
Zn	3.03	2.61		4.16	3.51		
Cu	1.39	1.27		1.36	1.25		

LSD=Least significant difference RB =Raw bracts BB = Blanched bracts. RFS= Raw floral stem. BFS**=** Blanched floral stem
Mean in a row not sharing the same letter are significantly at $p \leq 0.05$.
**-Capital latter A, B for difference between raw bracts and raw stem.
**-Small latter a, b for difference between raw and blanched for the same sample.
ND : Not determined.

Lombardo *et al.* (2011) reported that values of some minerals (Ca, Zn, Mn and Cu) for the floral stems of two cultivars in Italy were higher than that mentioned here. Lombardo *et al.* (2013) reported that the floral stems of five globe artichoke cultivars had values for K and Fe lower and Ca, Na, Cu and Mn higher than found in the present study. The same authors suggested the possibility to promote the consumption of globe artichoke floral stem as a good source of macro- and micro-minerals. Generally, the minerals profile of globe artichoke was significantly affected by genotype, head fraction, location and season. In literature it is documented that within the macro- minerals, K was the most abundant one while, F was the most abundant one among the micro- minerals in globe artichoke plant. As found by Rincon *et al.* (2007), K is the nutrient most absorbed by artichoke plants during the growing cycle. Pandino *et al.* (2011) stated that globe artichoke had a high level of K and mainly, compared to some vegetables, low Na/K ratio, which is important in preventing hypertension and cardiovascular diseases.

Sugars and inulin:

The data presented in Table (4) showed that globe artichoke by-products (bracts and floral stems) contained 22.71 and 35.61% total sugars, 4.32, 16.54% reducing sugars and 17.47 and 18.12% non-reducing sugars , respectively. These values showed significant differences between bracts and floral stems. Floral stems had sugars content higher than bracts. Simple diffusion of sugars, after getting solubilized, from the samples to the blanching water may account for the losses of the sugars during blanching. The results in Table (4) showed a significant difference in inulin content between raw bract and floral stems. Floral stems had higher inulin (7.67%) content than bracts (6.56%). The same Table revealed that bracts had value of inulin content lower than that found by Lattanzio *et al.* (2005) and Sharara and Ghoneim (2011) and within the results that reported by Pagano *et al.* (2016) ,while, the floral stem content of inulin was lower than that found by Sharara and Ghoneim (2011) . Generally, the blanching method of globe artichoke by-products (bracts and floral stems) had significantly lower inulin content. The percentage of decline ranged between 15.80 and 17.34% from bracts and floral stems, respectively. This means that, heat treatment has a negative effect on inulin content because inulin dissolves in hot water (Van Waes *et al.*, 1998).

Dietary fiber fractions:

Table (4) represents the dietary fiber fractions of globe artichoke by-products (bracts and floral stem). Also, it declares the effect of water blanching at 95^{0}C for (3 and 5 min, respectively) on the values of these fractions. The values of these fractions could be ranked in descending orders as follows: neutral detergent fiber (NDF) (46.36%), acid detergent fiber (ADF) (30.69%), cellulose (25.42%), hemi cellulose (15.67) and acid detergent lignin (ADL) (5.27%) for RB d.w. The fractions values of the RFS had the same ranking and were 33.24, 21.30, 14.87, 12.05 and 6.43%, respectively.

Table (4). Sugars, inulin and dietary fiber contents of globe artichoke by products (on dry weight basis)

Component (%)	Bracts		LSD	Floral Stem		LSD	LSD (RB&RFS)
	RB	BB		RFS	BFS		
Total sugar	$22.71^{Aa} \pm 0.19$	$20.81^{b} \pm 0.1$		$35.61^{Aa} \pm 0.12$	$32.73^{b} \pm 0.13$	0.8851	0.8851
Reducing sugar	$4.32^{Ba} \pm 0.19$	$3.71^{b} \pm 0.09$	0.3495	$16.54^{Aa} \pm 0.29$	$15.36^{b} \pm 0.3$	0.6805	0.5695
Non reducing sugar	$17.47^{Ba} \pm 0.16$	$16.25^{b} \pm 0.27$	0.5141	$18.12^{Aa} \pm 0.22$	$16.50^{b} \pm 0.26$	0.5551	0.4397
Inulin	$6.58^{Ba} \pm 0.12$	$5.54^{b} \pm 0.23$	0.417	$7.67^{Aa} \pm 0.14$	$6.34^{b} \pm 0.09$	0.279	0.3069
Neutral detergent fiber (NDF)	$46.36^{Aa} \pm 0.21$	$46.39^{a} \pm 0.19$	0.468	$33.35^{Ba} \pm 0.21$	$33.24^{a} \pm 0.2$	0.480	0.4957
Acid detergent fiber (ADF)	$30.69^{Aa} \pm 0.39$	$30.56^{a} \pm 0.33$	0.414	$21.30^{Ba} \pm 0.03$	$21.25^{a} \pm 0.17$	0.285	0.6291
Hemicelluloses' (NDF-ADF)	$15.67^{Aa} \pm 0.15$	$15.83^{a} \pm 0.11$	0.373	$12.05^{Ba} \pm 0.12$	$11.99^{a} \pm 0.07$	0.699	0.4446
Acid detergent lignin (ADL)	$5.27^{Ba} \pm 0.17$	$5.34^{a} \pm 0.15$	0.307	$6.43^{Aa} \pm 0.21$	$6.42^{a} \pm 0.38$	0.437	0.3176
Cellulose	$25.42^{Aa} \pm 0.54$	$25.22^{a} \pm 0.27$	0.978	$14.87^{Ba} \pm 0.15$	$14.83^{a} \pm 0.38$	0.665	0.9069

LSD=Least significant difference RB =Raw bracts BB = Blanched bracts. RFS= Raw floral stem. BFS= Blanched floral stem

Mean in a row not sharing the same letter are significantly at $p \leq 0.05$.

**-Capital latter A, B for difference between raw bracts and raw stem.

**-Small latter a, b for difference between raw and blanched for the same sample.

It's clear that, there were pronounced variation between the values of NDF, ADF, cellulose, hemicellulose and ADL of raw bracts and raw floral stem. All the values of RB were higher than that of RFS except ADL of RFS that was higher than that of RB. Statistical analysis gave the same results. The present results were in good agreement with those of bracts mentioned by Attia *et al*. (2016), also were in good agreement with the value of ADF (30%) that mentioned by Salman *et al*. (2014) for bracts. On the contrary, NDF, hemicelluloses and cellulose that determined in the artichoke bracts by the previous authors had lower concentration, while, ADL (10%) had nearly double the concentration found here. The data presented in the present work are in accordance with those reported by Sallam (2005) for floral stems. Blanching process had no effect on the values of the dietary fiber fractions and these results are confirmed by statistical analysis. Saura-Calixto and Goni (2006) and Saura-Calixto *et al*. (2007) reported that dietary fibre, especially from fruits and vegetables, is a carrier of bioactive compounds. Dietary fiber of fruit and vegetables transports a significant amount of polyphenols and carotenoids linked to the fiber matrix through the human gut.

Potato puree:

Potato puree is a delicious food used by all age groups. Addition of mashed globe artichoke floral stems core to mashed potato in preparing puree will fortify its nutritive value with valuable bioactive compounds such as, dietary fiber, inulin, polyphenols and flavonoids that had many therapeutic benefits. Table (5) summarizes the organoleptic properties, while Fig. (3) shows the general appearance of potato puree containing different concentration of floral stem core puree (0, 5,10,20,30 and 40%).

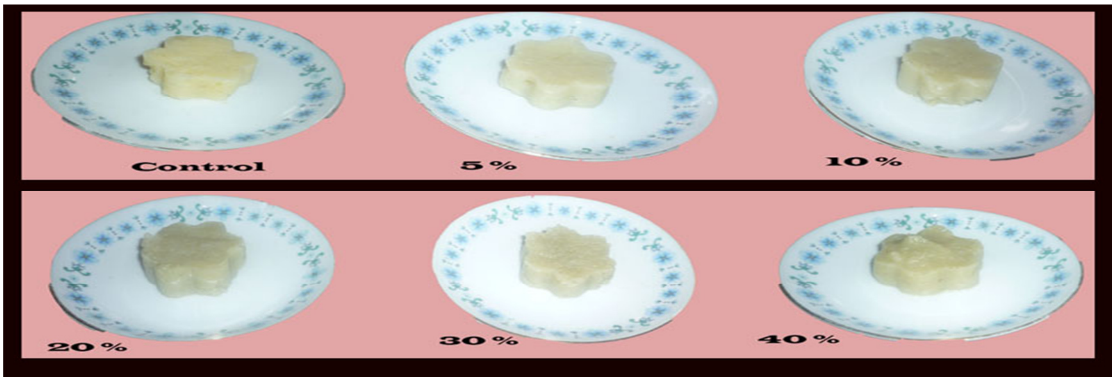

Fig. (3). General appearance of potato purees containing different concentration of BFSC

All the properties of all samples were accepted by the panelists. The most acceptable samples were that contain 5, 10, and 20 % floral stem core puree, these samples were described as like very much. The two other samples (contain 30 and 40% FSCP) were described as like moderately. Statically analysis revealed that there were no significant difference between potato puree containing 0, 5, 10 % FSCP in all properties except colour that had little significant difference. There were high significant difference between the three other samples potato puree containing 20, 30 and 40% FSCP.

Table (5). Organoleptic properties of potato puree containing different concentrations of globe artichoke by-products floral stems

Level of substitution (%)		Property				
Potato	BFSC	Colour	Texture	Flavour	Appearance	Total acceptability
100	-	9.00[a]	8.33[a]	8.55[a]	8.55[a]	8.55[a]
95	5	8.66[ab]	8.22[a]	8.22[a]	8.22[ab]	8.22[a]
90	10	8.33[b]	8.22[a]	8.22[a]	8.11[ab]	8.22[a]
80	20	7.55[c]	7.77[b]	8.11[ab]	8.00[b]	8.11[a]
70	30	6.88[d]	6.88[c]	7.66[b]	7.22[c]	7.22[b]
60	40	6.55[c]	6.77[c]	6.77[c]	6.77[c]	6.77[b]
LSD		0.418	0.4129	0.4695	0.5078	0.46.6

LSD= Least significant difference. BFSC=Blanched floral stem core.
Means in a column not sharing the same letter are significantly different at $p \leq 0.05$.

Biscuits:

Sensory characteristics of biscuits substituted with BB and BFS powder at different levels 0%, 2.5%, 5%, 7.5% and 10% were judged by the panelists. The organoleptic properties and the appearance of the products are shown in Fig.(4) and Table (6) . The scores showed that all samples contain BFS were accepted. Although the scores of organoleptic properties reduced by increasing the level of substitution, the organoleptic properties were described as like very much till 7.5% substitution, only biscuits contained 10% BFS was described as like moderately. Statistically, there were no significant differences between the three levels of substitution by BFS (0%, 2.5%, and 5%) in all properties. While, raising the substitution to 7.5 and 10% BFS caused significant differences.

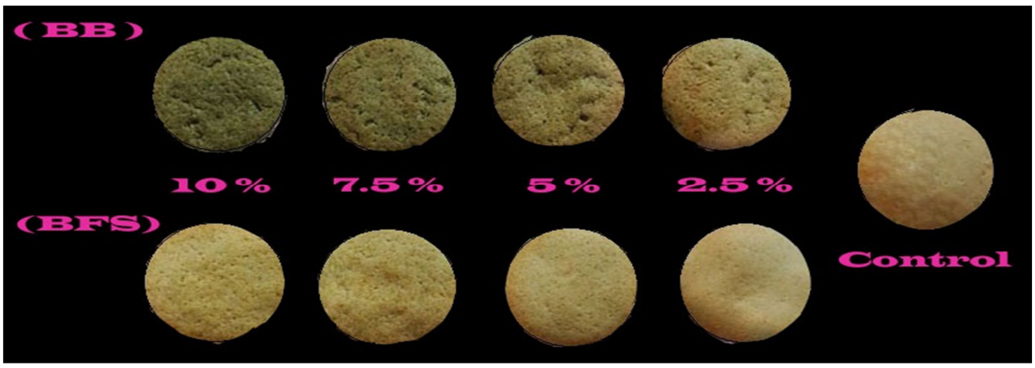

Fig. (4). General appearance of biscuits substituted with BB and BFS powder at different levels.

On the other hand, biscuits produced using BB with the same levels of BFS substitution had less acceptability. Only samples with 2.5% BB had scores that were described as like very much, while with 5, 7.5 and 10% had scores that were described as like moderately, like slightly and neither like nor dislike, respectively. Statistically, there were significant differences between all samples in all properties except colour and texture of biscuits with 2.5 % BB that had the same letter of the control. These results showed that the biscuits with the high levels (7.5 and 10 %) of BB had less acceptability. Based on sensory evaluation, the formulation containing higher levels of BFS were more acceptable by the panelists than BB.

Table (6). Organoleptic properties of biscuit containing different concentrations of globe artichoke by-products

Level of substitution (%)			Property				
Wheat flour	BB or BFS		Colour	Crispiness	Flavour	Appearance	Total acceptability
100	BB	0.00	8.44^{A}	8.44^{A}	8.44^{A}	8.55^{A}	8.44^{A}
	BFS	0.00	8.55^{a}	8.22^{ab}	8.22^{a}	8.33^{a}	8.22^{a}
97.5	BB	2.50	7.88^{A}	8.33^{A}	7.88 ^{B}	7.55^{B}	7.88^{B}
	BFS		8.22^{a}	8.44^{a}	8.00^{ab}	8.22^{a}	8.22^{a}
95	BB	5.00	6.66^{B}	7.55^{A}	7.33^{C}	7.00^{C}	7.33^{C}
	BFS		8.22^{a}	8.11^{ab}	7.66^{ab}	8.33^{a}	8.22^{a}
92.5	BB	7.50	6.33^{B}	7.44^{B}	6.66^{D}	6.33^{D}	6.44^{D}
	BFS		7.66^{b}	7.88^{b}	7.55^{bc}	7.66^{b}	7.55^{b}
90	BB	10.00	5.33^{C}	7.33^{B}	5.77^{E}	5.33^{E}	5.33^{E}
	BFS		7.33^{b}	7.77^{b}	7.22^{c}	7.33b	7.00^{c}
LSD	BB		0.6231	0.615	0.4435	0.4378	0.4602
	BFS		0.4602	0.5021	0.6272	0.4547	0.4971

LSD= Least significant difference. BB= Blanched bracts. BFS=Blanched floral stem.
Means in a column not sharing the same letter are significantly different at $p \leq 0.05$.
Capital latter for differences between properties of biscuit with different concentration of BB
Small latter for differences between properties of biscuit with different concentration of BFS.

Physical characteristics:

The effect of different concentrations of BFS and BB incorporated in physical characteristics of prepared biscuits are summarized in Table (7). These characteristics such as weight, thickness, diameter and spread ratio of biscuits substituted with BFS and BB powder at different levels 0, 2.5, 5, 7.5 and 10% were slightly affected by the substitution. The values of weight, diameter and thickness were relatively close to the control, while the spread ratio was slightly increased. It can be concluded that the substitution of wheat flour by globe artichoke waste (BB and BFS sup to 10%) enhance nutritive value of biscuits with very slight effect on its physical characteristics.

Table (7).Physical characteristics of biscuits containing different concentrations of BB and BFS

Product / Characteristic		Control 100% (wheat flour)	Biscuits containing BB or BFS			
			2.5%	5%	7.5%	10%
Weight (g)	BB	6.41±0.08	6.47 ±0.05	6.46±0.08	6.59±0.05	6.61±0.11
	BFS		6.61 ±.09	6.21±0.11	6.59±0.12	6.63±0.16
Diameter (cm)	BB	4.73±0.09	4.84 ±0.03	4.83±0.04	4.84±0.05	4.87±0.03
	BFS		4.78 ±.0.10	4.82±.0.07	4.80±.0.06	4.81±..07
Thickness (cm)	BB	0.42±0.03	0.39 ±0.01	0.38±0.02	0.40±0.02	0.38±0.01
	BFS		0.39 ±.02	0.40±.03	0..39±.02	0.38±.02
Spread ratio	BB	11.26± 0..9	12.41 ±0..36	12.71±0..4	12.10±0..37	12.81±0..39
	BFS		12.26 ±0.77	12.05±0.79	12.31±0.27	12.66±0.73

BB: Blanched bracts. BFS: Blanched floral stem.

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الملخص العربي

تقييم مخلفات الخرشوف لتدعيم الخصائص الوظيفية لبعض الأغذية

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أهتمت هذه الدراسة بتقدير كل من التركيب الكيماوى التقريبي ، المحتوى من المعادن، وبعض المركبات الحيوية ، وتأثير عملية السلق لثبيط إنزيم البولى فينول أوكسيديز علي تلك الخصائص لمخلفات تصنيع الخرشوف (القنابات والسيقان الزهرية) وإمكانية إستخدام تلك المخلفات في إعداد بعض الأغذية الوظيفية– أظهرت النتائج أن أعلى المكونات قيمة هو المستخلص الخالي من النيتروجين وكان هناك محتوي كبير من الألياف الخام . تحتوي القنابات الخام والسيقان الزهرية الخام على٥٠,٣٤ – ٥٥,٠٠ % مستخلص خالي من النتروجين و٢٤,٨٤– ١٤,٨٨% من الألياف الخام على التوالي . أوضحت قيم مكونات الألياف التغذوية أنه يمكن ترتيبها تنازليا على النحو الأتي : الألياف التغذوية المتعادلة (٤٦,٣٦ و٣٣,٢٤ %)، الحامضية (٣٠,٦٩ و ٢١,٣ %)، السليلوز (٢٥,٤٢ و ١٤,٨٧%) ، الهيميسلسلوز (١٥,٦٧ و١٢,٠٥ %) ، اللجنين (٥,٢٧ و٦,٤٣ %) للقنابات والسيقان الزهرية على التوالي ، وكانت السيقان الزهرية الأعلي فى محتوي الإنيولين (٧,٦٧%) مقارنة بالقنابات (٦,٥٦ %) . تعتبر القنابات و السيقان الزهرية مصدر جيد للعناصر الكبرى و الصغرى، ويعد البوتاسيوم العنصر السائد فى العناصر الكبرى (٣٠٨٩,١٢ و ٣١٥٢,٧١ ملجم/١٠٠ جم وزن جاف) ، بينما الحديد هو العنصر السائد في المعادن الصغرى (١٤,٩٥ و١٣,٨٧ ملجم /١٠٠ جم وزن جاف) علي التوالي . أظهر التقييم الحسى إمكانية إستخدام تلك المخلفات فى تدعيم بيورية البطاطس و البسكويت ، وكانت عينات البيورية المحتوية على (٥ و ١٠و ٢٠ % مهروس السيقان) هى الأكثر تقبلاً ، بينما عينات البسكويت المحتوية على (٢,٥ و ٥ و ٧,٥% سيقان مسلوقة مجففة) و (٢,٥ % قنابات مسلوقة مجففة) هى الأكثر تقبلاً– واظهرت تلك الإستبدالات تأثير قليل جداً علي الخصائص الفيزيائية للبسكويت .