Journal of Food and Dairy Sciences

Journal homepage: www.jfds.mans.edu.eg
Available online at: www.jfds.journals.ekb.eg

Utilization of Nabaq Fruit Nutritional Value and Antioxidant Activity in Some Food Products

Saadia M. Hashem* **and M. S. Abd El-Lahot**

Food Science & Technology Dept., Fac. of Agric. El- Shatby, Alexandria Univ., Alexandria, Egypt

Cross Mark

ABSTRACT

Nabaq (*Zizyphus spina- christi*) has various functional and technology properties, which can be used as a natural source of therapeutic functional compounds. The physicochemical properties, bioactive compounds, and antioxidant activities, of the pulp and seeds of Nabaq fruit from Egypt and its application in some functional products were investigated. The results revealed that the dehydrate seeds contain high contents of crude protein (9.64%), and ether crude extract (13.95%), while, dehydrate pulp had high content of total carbohydrates (90.94%). The carbohydrate fractions were found to be ranged from 4.05 to 16.61% starch, 28.87 to 43.52% reducing sugars, 9.72 to 27.19%, sucrose, and 4.5 to 18.45% glucose in seeds and pulp, respectively. The Nakaq pulp was a good source of dietary fiber, vitamin C, and minerals especially Zn which where realized approximately 106.5% of daily requirements. The pulp was also characterized by higher total phenolics (46.62 mg/g) and flavonoids (165.68 mg/100g) than the seed which had IC_{50} values 13.88 mg/ ml for 36.02% inhibition of DPPH free radicals. The evaluation of sensorial attributes of biscuits products prepared with powdered Nabaq seeds as replacement of wheat flour (20%) and fat (25%) showed the highest sensory overall acceptability scores. Cookies products prepared with powdered Nabaq pulp as a substitution of 10% wheat flour showed nearly closed acceptability to the control while cakes containing 20% pulp gave the highest score of sweetness, flavour, overall acceptability. Also, pudding containing 50% Nabaq pulp had the highest overall acceptability in all sensory attributes.

Keywords: Nabaq fruits, functional compounds, cookies and technology properties.

INTRODUCTION

Nowadays, global strategies are focused on using natural wild fruits that rural people use them for traditional medicine as a functional foodstuffs. Sidr (*Zizyphus spina-christi* L) named Nabaq, and many local names such as Nibs, Jabat, Zefzoof, Ardeg, Ghosl, and Kanar, is an medicine edible forest fruits which are source of the nutritional value of the diet with macro and micronutrients in the rural areas (Sameera and Mandakini, 2015). It is a tree belonging to the family (Rhamnaceae), live naturally in the warm areas and tropical regions and Arabia which has historical, medicinal and religious benefits (Gultekin, 2007 and Ahmed, 2016). The phytochemical components of *Zizyphus spina- cristi* are, carbohydrates (up to 82.7% in fruits), protein (4.8- 38.79% in seed), oil (up to 28.89% in seeds), fatty acid, besides many minerals, polyphenols and vitamins which can be used in the food and the pharmaceutical industry. The active compounds of Nabaq such as alkaloids, flavonoids, saponins, tannins, terpenoids, and glycosides, have numerous biological properties including ,antioxidant, antimicrobial, antifungal, antihypertensive, antihyperglycemic and anti-diabetic, as well as anticancer, (Said *et al*., 2006, Ahamed, 2016 and Khaleel *et al*., 2016). The Nabaq seeds are a source of sulphur-rich amino acids and linoleic acid which showed high activity against *Escherichia coli* and *Bacillus subtilis* (Nazif, 2002). The Nabaq pulp has sweet taste as well as natural nutritive source and can be consumed either fresh or dehydrate in the manufacture of candy (Adekunle and Adenike, 2012 and El Maaiden *et al*., 2019). It showed biological activities such as antioxidants, active against bacterial and fungal pathogens antidiarrheal, antitumor and immunostimulatory activities (Adzu *et al*., 2003, and Abalaka *et al*., 2011). In addition, research has shown that lesser work has been carried out on these fruits and seeds in Egypt. Therefore, the present study was undertaken to evaluate the proximate chemical composition, the total phenolics, flavonoids, bioactive compounds contents and antimicrobial activity of the pulp and seeds of Nabaq fruit. Moreover, utilization of such fruits in preparing some functional products were also studied.

MATERIALS AND METHODS

Materials:

Five kg of the fresh Nabaq fruits (*Ziziphus spina-christi*), wheat flour (72% extraction), powdered sugar, eggs, milk, and the other ingredients mentioned in the present work were purchased from the local market, Alexandria, Egypt.

Chemicals

All chemicals used were of analytical grade and purchased from El-Gamhouria Co. for Chemical and Medical Requistes, Alexandria, Egypt. DPPH reagent (1, 1-diphenyl -2 -picrylhydrazyl) was obtained from Sigma Company, Germany.

Methods:

Preparation of plant material

The fresh Nabaq fruits were cleaned with tap water and carefully separated into pulps and seeds (Fig. 1) using a

* **Corresponding author.**
E-mail address:sadia.mohamed831@gmail.com
DOI: 10.21608/jfds.2021.69882.1020

stainless-steel knife. Fruit pulp and seeds were dehydrated at 45ºC for 12 h in a thermostatically controlled hot air oven (Memmert UN750, Germany). The dehydrated pulp and seeds were ground using a milling machine (Culatti Hammer Mill DCFH 48, Germany), then packed in air-tight Kilner jar and stored in a refrigerator (4ºC) until used.

Fig. 1. The general appearance of fruits and seeds of Nabaq *(Z. spina-christi)*.

Chemical methods

Proximate chemical composition including moisture, crude protein, crude ether extract, total ash and crude fiber of Nabaq fruit pulp and seed were determined according to the AOAC (2007) methods under unless otherwise stated. Carbohydrate content was calculated by difference. Starch, reducing sugar, glucose and titratable acidity of Nabaq fruit pulp and seed were also analyzed according to the procedures of AOAC (2007). Total sugars were determined by phenol-sulfuric method described by (Dubois *et al*., 1956). pH was measured using Beckman pH meter (pH MVx100 Beckman, USA) as described by Goulas and Kontominas (2007). The energy value was calculated according to the method described by Crisan and Sands (1978).

Minerals content

Minerals content (Ca, Fe, Na, K and Zn) were estimated in ash solution using an inductively coupled plasma atomic emission spectroscopy (ICP-OES) (Model 2380, England) as described in AOAC (2007).

Bioactive compounds content

Dietary fiber fractions

Neutral detergent fibers (NDF), acid detergent fibers (ADF), and acid detergent lignin (ADL) were determined according to the methods described by AOAC (2007) method No 985.29 using an Ankon 220 Fiber Analysis Unit (Model No. A200, USA). Cellulose and hemicellulose were calculated as follows %Cellulose = %ADF - %ADL, %Hemicellulose = %NDF - %ADF.

Ascorbic acid content

Ascorbic acid was determined using 2, 6 dichlorophenol indophenol dye as described in AOAC (2007).

Preparation of pulp and seed extracts

Dehydrated Nabaq pulp, and seeds were extracted with two solvent, deionized water, and 70% ethanol as described by Mabrouk (2017) under the following conditions: The ground samples were homogenized with the solvent (at a ratio 1: 10 w/v for 1 min) in an Ultra Turrax homogenizer (GLH02, United States) and shaken at 100 rpm in an orbital incubator (Model INR-200, Gallenkamp, UK) at room temperature (25± 2ºC, for 24 h) and the residues were re-extracted under the same conditions. The extracts were filtered through No.1 Whatman filter paper. The filtrates were concentrated under vacuum in a rotary evaporator (JAMES. Jobling and Co. Ltd., Staffordshire, UK) at 45ºC, then kept in brown bottles at -18ºC until used for analysis.

Total phenolics content

Total phenolic content (TPC) content in the aqueous and ethanolic extracts was determined by the Folin-Ciocalteu's reagent according to the method described by Laličić-Petronijević *et al*. (2016).

Total flavonoids content

Total flavonoids content in the aqueous and ethanolic extracts was determined spectrophotometrically by the method of Zarina and Tan (2013).

DPPH radical scavenging activity

Antioxidant activity was estimated by assessing the free radical activity of the 1, 1- Diphenyl-2-picryl-hydrazyl (DPPH) radical as the method described by Brand- Williams *et al*. (1995). The IC_{50} value is the concentration of sample extract (mg/ml) required to inhibit 50% of the DPPH radical was calculated.

Technological methods:

Biscuits preparation: Biscuits with cocoa were prepared according to the method described by Nor Aini *et al*. (1992) using the following ingredients as shown in Table (1). Replacing 10% of wheat flour and 25% of fat by dehydrated Nabaq seed powder were applied according to Gaines *et al*. (1992).

Chocolate chip cookies: Chocolate chip cookies were prepared by mixing all ingredients as shown in Table (1). The dehydrated Nabaq pulp powder was used for the substitution of wheat flour at ratio 10 % as described by Abu-tor *et al*. (2012).

Cake preparation: Cake was prepared by replacing 10 and 20% of total wheat flour with dehydrate Nabaq pulp powder according to Nor Aini *et al*. (1989) using the following ingredients: in Table (1).

Table1. Ingredients used for the preparation of biscuits, chocolate chip cookies and cake.

Ingredients (g)	Biscuits	Chocolate chip cookies	Cake
Wheat flour	250.0	340.0	475.0
Sugar	100.0	64.0	460.0
Golden brown sugar	-	176	-
Fat	100.0	182.0	169.0
Chocolate chips	-	125.0	-
Whole eggs	50.0	107.0	236.0
Water	40.0	-	230.0
Skimmed milk powder	7.0	-	11.0
Baking powder	4.0	2.5	11.0
Salt	1.0	3.0	5.0
Vanillia	1.25	4.5	1.0

Cacao- pudding: The cacao- pudding was made from the Nabaq pulp powder which was replaced with 25, 50, and 75% cacao using skimmed milk 71.85 g, sugar 14.8 g with 8.5 g cream and 1.35 g konjac gum. All the ingredients were mixed then heated in a stainless-steel boiler at 85± 5ºC for about 20 min and poured into sterilized glass cups. After cooling at room temperature, the pudding was placed in the refrigerator for about 2 h (Irkin and Guldas, 2011).

Sensory evaluation

The sensory properties in colour, flavour, taste, texture and overall acceptability of all products were evaluated using a hedonic rating test. Samples were served to the trained panelists (20 panelists) of Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Egypt. The panelists were asked to rate the acceptability of the product on 1-9 points scale, ranging from the like extremely (9) to dislike extremely (1) as described by Meilgaard *et al.* (2007).

Statistical analysis

Analysis of variance was carried out according to Gomez and Gomez (1984) using SAS (Statistical Analysis System) ver.9.1, 2000.

RESULTS AND DISCUSSION

Proximate composition and caloric value of dehydrated Nabaq fruit

The results of the proximate chemical composition of dehydrated Nabaq fruit pulp and seeds are shown in Table (2). The moisture content varied from 9.38 to 17.56% in seeds and pulp, respectively. Total carbohydrate was represented the major component of the total solids of Nabaq fruit. The dehydrated fruit pulp had high contents in carbohydrate 90.94% whereas dehydrated seeds contains 73.94% carbohydrate. The carbohydrate content agreed with that found by Abdelmuti (1991) and Li *et al.* (2007). On the other hand, it was higher than that reported by Adekunle and Adenike (2012), Amoo and Atasie (2012) and Ahmed and Sati (2018) who found a carbohydrate content (dry matter) in the range of 58.02 to 82.7% in fruit pulp and 11.5 to 35.25% in seeds. The crude protein content of dehydrated seeds was higher being 52.50% than that found in dehydrated pulp. Berry-Koch *et al.* (1990) and Dweck (2005) reported similar protein values 4.8- 5.6% for Nabaq fruits. The ether extract was low in dehydrated pulp (0.59%) comparison with in dehydrated seeds (13.95%) which was in close agreement to the range reported by Duke (1985), Nazif (2002) and Singh *et al.* (2012) showed that the lipids content in seeds was 28.5%. The total ash was 3.89% and 2.47% of dehydrated fruit pulp and seeds, respectively which agreed with the range reported by Yossef *et al.* (2011) and Ahamed (2016) and lower than that reported by Adekunle and Adenike (2012) who showed that the ash content was 7.92% in fruit and 5.82% in seeds. As it can be noted from Table (2), the fiber content was higher (25.05%) in dehydrated seeds than the dehydrated pulp (2.51%). These values are in agreement with those obtained by Ahmed and Sati (2018). However, these results are in disagreement with Adekunle and Adenike (2012) who found that the crude fiber content of Nabaq ranged from 18.73 to 36. 63% and 6.09% in seeds and pulp, respectively. The variations in the proximate composition might be attributed to some factors such as variety, agro-climatic conditions, ripening stage, the harvesting time and environmental factors (Jumba *et al*., 1996). The Nabaq fruit is an good source of energy, providing 387.39 and 459.87 Kcal/100 g from Nabaq pulp and seeds, respectively.

Table 2. Proximate composition and caloric value of pulp and seeds of dehydrated Nabaq fruit.

Components*	dehydrated Pulp	dehydrated Seeds
Moisture (%)	$17.56^{b}\pm 0.39$	$9.38^{a}\pm 0.16$
Crude protein (%)	$4.58^{b}\pm 0.13$	$9.64^{a}\pm 0.31$
Crude ether extract (%)	$0.59^{b}\pm 0.03$	$13.95^{a}\pm 0.20$
Total ash (%)	$3.89^{b}\pm 0.12$	$2.47^{a}\pm 0.08$
Total carbohydrates** (%)	$90.94^{b}\pm 0.21$	$73.94^{a}\pm 0.20$
Crude fiber (%)	$2.51^{a}\pm 0.05$	$25.05^{b}\pm 0.19$
Total caloric value (kcal/100 g)	$387.39^{a}\pm 1.63$	$459.87^{b}\pm 3.84$

Mean values with different superscripts in the same row are significantly different (p≤ 0.05).
***On dry weight basis except moisture** ****Calculated by difference.**

The contents of evaluated elements for dehydrated Nabaq pulp and seeds and dietary reference values (DRVs) for minerals which include the average value adequate intakes (AIs) and reference intake (RIs) ranges for minerals were shown in Table (3). The data indicated that the dehydrated Nabaq pulp was a good source of the analyzed minerals, and exhibited the lowest contents of Ca (146.53 mg/100 g), K (790.75 mg/100 g), Na (80.33 mg/100 g), Fe (10.20 mg/100 g) and Zn (14.91 mg/100 g) than seeds. Ca, K, Fe, and Zn in pulp were approximately 15.42%, 22.59%, 63.75%, and 106.5% of daily requirements (PRI/AI), respectively. Therefore, it can be suitable for dietary supplements and blood building. This value was higher than the values found by El Maaiden *et al*. (2020) who exhibited that Ca K, and Na of Nabaq were78.37 to 74.80, 203.20 to 179.65, and 33.70 to 22.77 mg/100 g, respectively and disagreed with the results reported by Djemai (2009), who found that Nabaq seeds had the highest mineral content when comparison with pulp. Variations in mineral content can be caused by a number of factors, including variety, soil quality, irrigation regime, harvest period, maturation, storage conditions, and state of ripeness in different types of fruits and within different sections of the same fruit (Leterme *et al*., 2006).

Table 3. Minerals content for fruit pulp and seeds of Nabaq fruits.

Components	Minerals (mg/100 g dry weight basis)				
(%)	Calcium (Ca)	Potassium (K)	Sodium (Na)	Iron (Fe)	Zinc (Zn)
Pulp	146.53± 0.55	790.75± 0.67	80.33± 0.49	10.20± 0.03	14.91± 0.38
Seeds	124.32± 0.23	114.14± 0.08	54.99± 0.70	2.10± 0.33	0.95± 0.04
Dietary reference values (DRVs)*	950-1000	3500	2000	16	12.7-16.3

***European Food Safety Authority Dietary Reference Values for Nutrients Summary Report. (2017).**

Physicochemical and carbohydrate composition of Nabaq pulp, and seeds

The total acidity of dehydrate Nabaq was slightly higher for pulp (1.15%) than that of the seed (1.02%) (Table 4). On the other hand, pH values for both pulp and seed were 3.95 and 4.07, respectively. Nabaq fruit is characterized by sweet taste due to its high amount of total carbohydrate. Table (4) revealed that the starch content of the pulp and seeds was 18.26 and 4.48%, respectively of the total carbohydrate. The sugar fractions of the pulp were total sugars 71.08%, reducing sugars 43.52%, sucrose 27.19%, and glucose 18.45%, which were higher increase than that of the seeds being 44.99, 33.66, 64.24 and 72.91%, respectively and differ from those reported by Abdelmuti (1991) and Saied *et al.* (2008) who found that dehydrate Nabaq fruits contains 21.8% starch, 22.6 total reducing sugars, 21.8% sucrose, 9.6% glucose and 16% fructose. Amoo and Atasie (2012) showed that the reducing sugars of Nabaq fruit and seed were dextrose, fructose, maltose, and lactose.

Table 4. Physicochemical and carbohydrates composition of dehydrated Nabaq pulp, and seeds.

Components	pH value	Titritable Acidity (%)	Vitamin C (mg/100 g)	Starch (%)	Total sugar (%)	Reducing sugars(%)	Sucrose (%)	Glucose (%)
Pulp	3.95ª± 0.01	1.15ᵇ± 0.08	18.95ᵇ± 0.18	16.61ᵇ± 0.36	71.08ᵇ± 0.04	43.52ᵇ± 0.11	27.19ᵇ± 0.53	18.45ᵇ± 0.81
Seeds	4.07ᵇ± 0.02	1.02ª± 0.03	6.66ª± 0.07	4.05ª± 0.10	39.10ª± 0.46	28.87ª± 0.24	9.72ª± 0.65	4.5ª± 0.37

Mean ± SD of triplicate analysis. LSD: Least significant differences.
Mean in a row not sharing the same letter are significantly different at p ≤ 0.05.

Bioactive compounds and antioxidant activity of dehydrated Nabaq fruit pulp, and seeds

Dietary fiber, phenolic compounds and flavonoids can serve in pharmaceutical and medical aspects as antibacterial, antiviral, antitumor, antifungal, antioxidant which promote a positive of the immune system (Fernández-Quintela *et al*., 2020).

Dietary fiber fractions of dehydrated Nabaq fruit pulp, and seeds (on dry weight basis).

The dietary fiber fractions of dehydrate Nabaq pulp and seeds are graphically presented in Fig. (2).

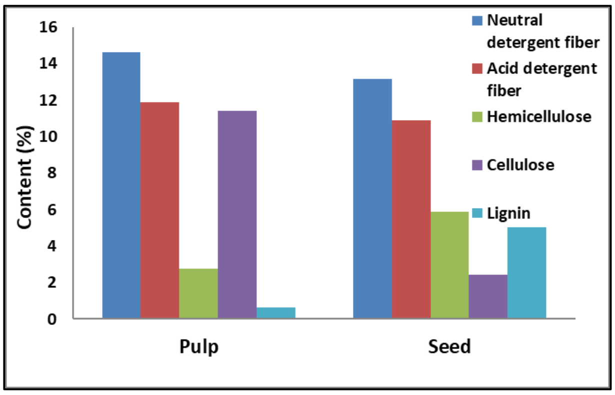

Fig. 2. Dietary fiber fractions of dehydrated Nabaq pulp, and seeds Nabaq fruit pulp and seeds (on dry weight basis).

The results indicated that there was a difference between dietary fiber fractions between the two parts. The pulp was the highest of neutral detergent fiber (NDF) and acid detergent fiber (ADF) than that in seeds. The dietary fibers of seeds that can be ranked in a descending order as follows, NDF (14.04%), ADF (10.9%), lignin (8.46%) hemicellulose (3.14%), and cellulose (2.44%) whereas it can be arranged in descending order as follows NDF (23.22%), ADF (14.61%), cellulose (11.08%), hemicellulose (8.61%) and lignin (5.49%) for pulp. Natural dietary fiber is important due to their functional and technology properties and play a significant role in the enhancement of immune system, and reduces risk non communicable diseases including obesity, diabetes, cancer, diabetes, and cardiovascular disease (Venter *et al*., 2020).

Vitamin C: Vitamin C content of dehydrated pulp and seeds were found to be 18.95 and 6.66 mg/100 g, respectively (Table 4). This value was lower than that reported by Berry-Koch *et al.* (1990) who stated that fruit pulp contain 0.03% ascorbic acid. On the other hand, it was higher than that reported by Ahmed and Sati (2018) who found that ascorbic acid content was 8.64 mg/100 g in pulp Singh *et al*. (2012). Orwa *et al*. (2009) reported a value of vitamin C. was 1.6%. Vitamin C also known as L-ascorbic acid, plays an important role in biosynthetic and antioxidant functions, In addition to its improves the absorption of iron and tin immune function (Gershoff, 1993).

Phenolics and flavonoids contents and antioxidant activity of dehydrated Nabaq pulp, and seeds

Extraction yield of phenolics and flavonoids compounds from dehydrate Nabaq pulp, and seed are shown in Table (5). The data revealed that the efficiency of water extraction method afforded the highest yield in different part of Nabaq fruits compared to ethanolic extraction. Type and polarity of solvent affected on total phenolics and extract yield (Quy *et al*., 2014). The data showed that the dehydrate pulp gave the highest yield either by water extraction or ethanol extraction compared to the dehydrate seeds. The phenolics content was found in water extract of dehydrate pulp (46.62 mg GAE/ g extract), and 44.78 GAE/ g extract in dehydrate seeds. In the same respect, ethanol extract of Nabaq pulp contain the highest flavonoids content (180.01 mg CE/ g extract) compared to seeds. These results are in agreement with El Maaiden *et al.* (2019) who found that extraction with water gave the highest phenolics (39.74 mg gallic acid equivalent / g of dry weight of the seeds of Nabaq while extraction with methanol gave the highest flavonoids content (14.58 mg quercetin equivalent/ g of dry weight) in the *Z. lotus* seeds .

Table 5. Total phenolics and flavonoids compounds and antioxidant activity of dehydrate Nabaq pulp and seeds

Component	Nabaq Fruits			
	Dehydrate pulp		Dehydrate seeds	
	Ethanolic extract	Water extract	Ethanolic extract	Water extract
Total phenolics(mg/ g)	22.10ª± 0.34	46.62ᵇ± 0.59	17.41ª± 0.33	44.78ᵇ± 0.20
Total flavonoids(mg/ 100 g)	180.01ᵇ± 1.46	165.68ª± 0.73	170.87ᵇ± 0.87	104.06ª± 0.66
Radical scavenging activity (%Inhibition)	41.42ª± 0.21	67.47ᵇ± 0.69	36.02± 0.70ª	37.28ᵇ± 0.49
IC_{50} (mg/ ml)	12.07ᵇ	7.41ª	13.88ª	13.41ª

Mean ± SD of triplicate analysis. LSD: Least significant differences. Mean in a column not sharing the same letter are significantly different at p ≤ 0.05.

The differences in the phenolic potential might depend on a type and source of Nabaq. El Maaiden *et al*. (2020) founded that Nabaq seeds from Morocco contained the highest average values of total phenolic content (30.24 mg GAE/ g DW), with DPPH (64.87%).The antioxidant activity depends on the test system, the isolation procedures, as well as the polarity of the solvent. Generally, the antioxidant activity was higher in extracts obtained from pulp than extracts of seeds. The highest antioxidant capacity was found in water extract of pulp which showed 67.47% inhibition of DPPH radicals with an IC_{50} value of 7.41 mg/ ml compared with dehydrate seeds which had IC_{50} values 13.41 mg/ ml for 37.28% inhibition of DPPH free radicals. Phenolics and flavonoids compounds as a primary antioxidants can play an important role in absorbing and neutralizing free radicals, and hence prevent the progression of the diseases and cancers (Tungmunnithum *et al*., 2018). The fruit, pulp, seeds of Nabaq can be used as nutraceutical component in functional, health-enhancing foodstuffs (El Maaiden *et al*., 2020).

Organoleptic properties of the investigated Nabaq products:

Table (6) and Fig. (3) summarized the organoleptic properties of products containing level substitutions from dehydrate Nabaq powder. It was obvious that the mean scores for all the attributes of products were accepted by panelists, being over the numerical value of (7) that was described by panelists as "like very much" for both biscuits, cake and cocoa pudding 50% Nabaq, and "like moderately" for chocolate chip cookies and the cacao- pudding containing 25 or 75% dehydrate pulp. Statistical analysis of each of the assessed organoleptic property among the prepared products showed that the significant variation was noticed in the colour of such products. This variation was mainly due to difference in substitution levels used and processing during preparing of such products. Also, data in Table (6) showed that the biscuits products prepared with powdered Nabaq seeds replacing wheat flour (20%) and fat (25%) showed the highest sensory overall acceptability scores. The addition of dehydrate Nabaq seeds powder as a fat replacer enhanced the biscuit texture as comparison with the control this might be because of the higher amount of seeds oil. On the other hand, the mean scores for all sensorial properties of chocolate chip cookies prepared with dehydrated pulp as a substitution of 10% wheat flour were moderately acceptable and nearly closed acceptability to control.

Table 6. Organoleptic properties of some products preparing from dehydrated Nabaq seeds and pulp.

Tested products	Organoleptic properties*						
	Treatment	Colour	flavour	Taste	Texture	Appearance	Overall acceptability
Biscuits*	Control	$8.90^{b}\pm 0.63$	$8.70^{a}\pm 0.70$	$8.70^{a}\pm 0.52$	$8.60^{a}\pm 0.47$	$8.70^{b}\pm 0.97$	Like very much
	10%	$8.80^{b}\pm 0.97$	$8.90^{a}\pm 0.57$	$9.00^{a}\pm 0.79$	$8.80^{a}\pm 0.93$	$9.00^{c}\pm 0.12$	Like extremely
	20%	$7.40^{a}\pm 0.84$	$8.80^{a}\pm 0.69$	$8.90^{a}\pm 0.48$	$8.80^{a}\pm 0.15$	$8.20^{a}\pm 0.42$	Like very much
Chocolate chip cookies**	Control	$7.46^{a}\pm 0.95$	$7.30^{a}\pm 0.19$	$7.25^{a}\pm 0.85$	$8.00^{a}\pm 0.50$	$7.80^{a}\pm 0.80$	Like moderately
	10%	$7.30^{a}\pm 0.82$	$7.60^{a}\pm 0.59$	$8.20^{b}\pm 0.41$	$8.10^{a}\pm 0.73$	$7.90^{a}\pm 0.68$	Like moderately
Cakes	Control	$8.10^{a}\pm 0.88$	$8.10^{a}\pm 0.88$	$8.70^{a}\pm 0.79$	$8.10^{a}\pm 0.74$	$8.20^{a}\pm 0.63$	Like very much
	10%	$8.40^{b}\pm 0.53$	$8.50^{b}\pm 0.10$	$8.50^{a}\pm 0.69$	$8.60^{b}\pm 0.95$	$8.70^{b}\pm 0.39$	Like very much
	20%	$8.50^{ab}\pm 0.53$	$8.30^{ab}\pm 0.95$	$8.50^{a}\pm 0.71$	$8.50^{b}\pm 0.71$	$8.60^{b}\pm 0.52$	Like very much
Cacao- pudding	Control	$7.50^{a}\pm 0.52$	$7.80^{a}\pm 0.33$	$7.80^{a}\pm 0.49$	$7.20^{a}\pm 0.68$	$7.90^{b}\pm 0.32$	Like moderately
	25%	$7.50^{a}\pm 0.32$	$8.00^{a}\pm 0.90$	$7.70^{a}\pm 0.82$	$7.90^{b}\pm 0.86$	$7.20^{a}\pm 0.79$	Like moderately
	50%	$7.90^{b}\pm 0.99$	$8.70^{b}\pm 0.82$	$8.00^{ab}\pm 0.88$	$7.90^{b}\pm 0.92$	$8.10^{b}\pm 0.82$	Like very much
	75%	$8.00^{b}\pm 0 .99$	$8.00^{a}\pm 0.94$	$8.20^{b}\pm 0.74$	$7.60^{b}\pm 0.87$	$8.00^{b}\pm 0.92$	Like very much

Mean± SD of triplicate analysis. LSD: Least significant differences. Mean in a column not sharing the same letter are significantly different at $p \leq 0.05$.
***Biscuits prepared with dehydrated Nabaq seeds, **Cakes, Chocolate chip cookies and Cacao- pudding prepared with dehydrated Nabaq pulp.**

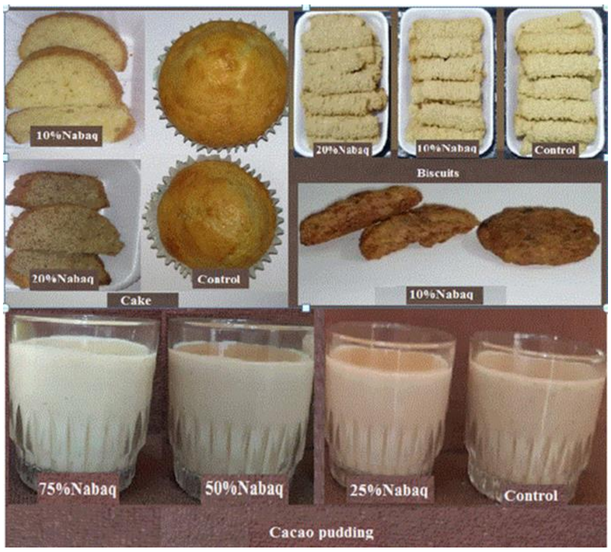

Fig. 3. The general appearance of some food products containing dehydrated Nabaq pulp and seeds.

Nabaq pulp- containing cakes up to a 20% substitution level gave the high score of taste, flavour, overall acceptability attribute as comparison to the control. This may be due a synergistic sweetening effect from Nabaq sugar (Schiffman *et al*., 1995).The data indicated that all the pudding prepared with 50% dehydrate Nabaq pulp as cocoa replacer had the higher score of overall acceptability compared with other samples. The pudding prepared with 75% dehydrate Nabaq pulp showed the highest intensity of flavour than the other samples. Also, the results indicated that no significant differences were noted in the organoleptic attributes between the control sample and pudding containing 50 and 75% dehydrated Nabaq pulp. Pudding containing 50% dehydrated Nabaq pulp had the highest overall acceptability in all sensory attributes.

CONCLUSION

Nabaq seeds was rich of fat and protein content while pulp was source of energy, phenolic compounds, and natural antioxidant. Therefore, it could be considered as a valuable ingredient for functional food product.

REFERENCES

Abalaka, M. E., Mann, A. and Adeyemo, S. O. (2011). Studies on in-vitro antioxidant and free radical scavenging potential and phytochemical screening of leaves of *Ziziphus mauritiana* L. and *Ziziphus spinachristi* L. compared with ascorbic acid. J. Med. Genet. Genom. 3 (2): 28-34.

Abdelmuti, O. M. S. (1991). Biochemical and nutritional evaluation of famine foods of the Sudan. Doctoral Dissertation in Biochemistry and Nutrition, University of Khartoum, Sudan.

Abu-Tor, E. S. M., Abdel-Nabey, A. A. and Sherin, F. A. Awd Allah. (2012). Utilization of drying mushroom flour in some functional food products. Alex. J. Fd. Sci. and Technol. 9: 33- 45.

Adekunle, A. I. and Adenike, J. O. (2012). Comparative analysis of proximate, minerals and functional properties of *Tamarindus indica* pulp and *Ziziphusspina christi* fruit and seed. Greener Journal of Agricultural Sciences 2(1): 21- 25.

Adzu, B., Amos, S., Amizan, M.B., and Gamaniel, K. (2003). Evaluation of the antidiarrhoeal effects of *Zizyphus spina-christi* stem bark in rats. Acta Tropica. 87(2): 245- 250.

Ahamed, E. M. M. (2016). Characterization and Biological Activity Study of *Ziziphus spina-Christi* Seed Oil. M Sc., Thesis, Science and Technology College of Graduate Studies, Sudan University, Sudan.

Ahmed, F. A. M. and Sati, N. M. E. (2018). Chemotaxonomic study and botanical overview of some *Ziziphus spp.* in Sudan. Int. Res. J. Biol. Sci. 7(5): 32- 39.

Amoo, I. A. and Atasie, V. N. (2012). Nutritional and functional properties of *Tamarindus indica* pulp and *Zizyphus spina- christi* fruit and seed. Journal of Food Agriculture & Environment 10: 16-19.

AOAC. (2007). Official Methods of Analysis. (18th Ed) Association of Official Analytical Chemists. Maryland. USA.

Berry-Koch, A., Moench, R., Hakewill, P. and Dualeh, M. (1990). Alleviation of nutritional deficiency diseases in refugees. Food Nutr. Bull. 12: 106-112.

Brand- Williams, W., Cuvelier, M. E. and Bersct, C. (1995) . Use of a free radical method to evaluate antioxidant activity . Lebensmittel Wissenschaft and Technologie 28: 25- 30.

Crisan, E. V. and Sands, A. (1978). Nutritional Value of Edible Mushroom, In: Chang S. T. and Hayer, W. A., Eds., Biology and Cultivation of Edible Mushrooms, Academic Press, New York, pp. 137- 168.

Djemai, Z.S. (2009). Etude de l'activité biologique des extraits du fruit de *Zizyphus Lotus L*. (Mémoire de master). Université El HadjLakhdar, Batna.

Dubois, M., Gilles, K., Hamilton, J., Rebers, P. and Smith, F. (1956). Colorimetric method for determination of sugars and related substances. Analyt Chem. 28: 350- 6.

Duke, J. A. (1985) Handbook of Medicinal Herbs. Florida, USA: CRC Press, Inc. p 677.

Dweck, A. C. (2005). A review of *Zizyphusspina-christi*. Personal Care Magazine Series.

El Maaiden, E., El Kharrassi, Y., Lamaoui, M., Allai, L., Essamadi, A. K., Nasser, B. and Moustaid, K. (2020). Variation in minerals, polyphenolics and antioxidant activity of pulp, seed and almond of different *Ziziphus species* grown in Morocco. Brazilian Journal of Food Technology 23: 201- 206.

El Maaiden, E., El Kharrassi, Y., Moustaid, K., Essamadi, A. K. and Nasser, N. (2019). Comparative study of phytochemical profile between *Ziziphus spina christi* and *Ziziphus lotus* from Morocco. Food Measure 13(1): 121-130.

European Food Safety Authority Dietary Reference Values for Nutrients Summary Report. (2017). EFSA Support. Pp. 14 -121.

Fernández-Quintela, I. M., Jenifer, T., Saioa, G., Naroa, K., Asier, L., Marcela, G. and María, P. P. (2020). Key Aspects in Nutritional Management of COVID-19 Patients. J. Clin. Med. 9: 2589.

Gaines, C. S., Kassuba, A., Finney, P. L. and Donelson, J. R. (1992). Instrumental measurement of cookie hardness. II. Application to prod-uct quality variables. Cereal Chem. 69:120-125.

Gershoff, S. N. (1993). Vitamin C (ascorbic acid): new roles, new requirements. Nutr. Rev. 51(11): 313- 26.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research (2nd ed.). John Wiley and sons, New York.

Goulas, A. E. and Kontominas, M. G. (2007). Combined effect of light salting modified atmosphere packaging and oregano essential oil on the shelf of sea bream (*Sparus aurata*). Bio chem. 100: 287-296.

Gultekin, H. (2007). An unknown fruit (jujube). Popular Science Journal 11: 41- 43.

Irkin, R. and Guldas, M. (2011). Evaluation of cocoa-pudding as a probiotic food carrier and sensory acceptability properties. Acta Agriculturae Slovenica 97: (3) 223 - 232.

Jumba. I. O., Suttle, N.F. and Wandiga, S. O. (1996). Mineral composition of tropical forages in the mount Elgan region of Kenya. 1. Macro minerals. Tropical Agriculture 73: 108- 112.

Khaleel, S. M. J., Jaran, A. S. and Haddadin, M. S. Y. (2016). Evaluation of total phenolic content and antioxidant activity of three leaf extracts of *Ziziphus spina-christi* (Sedr) grown in Jordan. British Journal of Medicine and Medical Research 14: 1- 8.

Laličić-Petronijević, J., Komes, D., Gorjanović, S., Belščak-Cvitanović, A.,, Pezo, L., Pastor, F., Ostojić, S., Popov-Raljić, J. and Sužnjević, D. (2016). Content of total phenolics, flavan-3-ols and proanthocyanidins, oxidative stability and antioxidant capacity of chocolate during storage. Food Technology and Biotechnology 54 (1): 13-20.

Leterme, P., Buldgen, A., Estrada, F. and Londoño, A. M. (2006). Mineral content of tropical fruits and unconventional foods of the Andes and the rain forest of Colombia. Food Chemistry 95(4): 644 652.

Li, J. W., Fan, L. P., Ding, S. D. and Ding, X. L. (2007). Nutritional composition of five cultivars of Chinese jujube. Food Chemistry 103: 454- 60.

Mabrouk, M. S. (2017). Exploratory chemical and technological studies on Moringa (*Moringa oleifera*) leaves. M. Sc. Thesis, Fac. of Agric., Alex. Univ., Egypt.

Meilgaard, M., Civille, G. V. and Carr, B. T. (2007). Sensory Evaluation Techniques. 4th ed.: CRC press L. L. C. New York.

Nazif, N. M. (2002). Phytoconstituents of *Ziziphus spina-christi* L. fruits and their antimicrobial activity. Food Chem. 76: 77- 81.

Nor Aini, I., Berger, K. G. and Qng, A. S. H. (1989). Evaluation of shortenings based on various palm oil products J. Sci. Food Agric. 46, 481- 193.

Nor-Aini, I., Embong, M. S., Abdallah, A., and Oh, F. C. H. (1992). Characteristics and performance of some commercial shortenings. Journal of the American Oil Chemists Society 69: 912-916.

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Anthony, S. (2009). Agroforestree database: a tree reference and selection guide version.

Quy, D., Diem, D., Artik, E. A. and Phuong, L. T. (2014). Effect of extraction solvent on total phenol content, total flavonoid content, and antioxidant activity of *Limnophila aromatica*, journal of food and drug analysis. 22: 296 -302.

Said, A., Huefner, A., Tabl, E. S. A. A. and Fawzy, G. (2006). Two new cyclic amino acids from the seeds and antiviral activity of methanolic extract of the roots of *Zizyphusspina-christi*. Paper presented at the 54th Annual Congress on Medicinal Plant Research. Planta Med 72.

Saied, A. S., Gebauer, J., Hammer, K. and Buerkert, A. (2008). *Ziziphus spina-Christi* (L.) Willd. a multipurpose fruit tree. Genetic Res. Crop Evol. 55: 929- 937.

Sameera, N. S. and Mandakini, B. P. (2015). Investigations into the antibacterial activity of *Ziziphus mauritiana* L. and *Ziziphus xylopyra* (Retz.) Willd. International Food Research Journal 22 (2): 498- 553.

Schiffman, S. S., Booth, B. J., Carr, B. T., Losee, M. L., Sattely - Miller, E. and Graham, B. G. (1995). Investigation of synergism in binary mixtures of sweeteners. Brain Res. Bull. 38: 105 - 120.

Singh, V., Guizani, N., Essa, M. M., Rahman, M. S. and Selvaraju, S. (2012). In vitro antioxidant activities of Ziziphus spina-christi fruits (red date) grown in Oman. Biotechnology 11: 209- 216.

Tungmunnithum, D., Thongboonyou, A., Pholboon, A. and Yangsabai, A. (2018). Flavonoids and Other Phenolic Compounds from Medicinal Plants for Pharmaceutical and Medical Aspects: An Overview. Medicines 5(3): 93.

Venter, C., Eyerich, S., Sarin, T., and Klatt, K. C. (2020). Nutrition and the Immune System: A Complicated Tango Nutrients, 12: 818.

Yossef, H. E., Khedr, A. A. and Mahran, M. Z. (2011). Hepatoprotective activity and antioxidant effects of El Nabka (*Zizyphus spina-christi*) fruits on rats hepatotoxicity induced by carbon tetrachloride. Nat. Sci. 9: 1- 7.

Zarina, Z. and Tan, S.Y. (2013). Determination of flavonoids in *Citrus grandis* (Pomelo) peels and their inhibition activity on lipid peroxidation in fish tissue. International Food Research Journal 20: 313- 317.

الإستفادة من القيمة الغذائية والنشاط المضاد للأكسدة لفاكهة النبق في بعض المنتجات الغذائية

سعدية محمد هاشم و مينا سميرعبد اللاهوت

قسم علوم وتقنية الإغذية - كلية الزراعة (الشاطبى) - جامعة الإسكندرية

ثمار النبق *Zizyphus spina- christi* تتميز بخصائصها الوظيفية والتكنولوجية التى يمكن الاستفاده منها كمصدر طبيعي للمركبات الوظيفية العلاجية. تهدف هذه الدراسة إلى تقييم الخصائص الفيزوكيميائية والمركبات النشطة حيويًا والنشاط المضاد للأكسدة فى لب وبذور ثمار النبق المنزرع فى مصر وكذلك الإستفادة منها فى إنتاج منتجات غذائيه وظيفية. أوضحت نتائج التحليل الكيماوى ان بذور النبق تحتوى على نسبة مرتفعة من البروتين و المستخلص الاثيرى، بينما يحتوى لب النبق المجفف على نسبة مرتفعة فى الكربوهيدرات الكلية (90.94٪). الكربوهيدرات تحتوى على نسبة تتراوح من 4.05 إلى 16.61 نشا و 28.87 إلى 43.52 سكريات مختزلة و 9.72 إلى 27.19٪ سكروز و 4.5 إلى 18.45٪ جلوكوز فى بذور ولب النبق على التوالي. كما أوضحت النتائج ان لب النبق مصدرًا جيدًا للألياف الغذائية وفيتامين ج والمعادن وخاصة الزنك حيث يوفر ما يقرب من 106.5٪ من الاحتياجات اليومية على التوالي . كما تميز لب النبق بارتفاع محتواه من الفينولات الكلية (46.62 ملجم/جم) والفلافونيدات (165.68 ملجم/100جم) مقارنة بالبذرة التى لها نشاط مضاد للأكسدة من خلال قيمة IC_{50} (13.88ملجم عينة / مل) لتثبيط 36.02 من الجذور الحرة (DPPH). واظهرت نتائج الاختبارات الحسية ان منتجات البسكويت المصنعة بإستبدال دقيق القمح (20٪) والدهون (25٪) بمسحوق بذور النبق المطحونه حازت على أعلى درجة قبول حسى من قبل المحكمين .وأظهرت منتجات الكوكيز المحضرة من مسحوق لب ثمار النبق المجففة بإستبدال 10٪ من دقيق القمح بها دون حدوث تغيرات عن المنتجات المرجعية بينما حاز الكيك المحتوى على 20٪ من اللب المخفف على أعلى درجة فى الخواص الحسية للحلاوة والنكهة والقبول العام. كذلك حاز البودنج المحتوى على 50٪ من لب بذور النبق على أعلى قبول عام فى جميع الصفات الحسية.

الكلمات الدالة: ثمار النبق ومركبات وظيفية و كوكيز و خواص تكنولوجية.