Effect of Different Pretreatments and Drying Techniques on some Chemical and Bioactive Components of Pumpkin Fruit Pulp

Abd El-razak, K. M[1].,Wafaa, A.A[1]., Zeitoun, M.A.M.[2] and El- Difrawy, E.A[2]
[1]Hort. Crop Processing, Res. Dept. Food Technol. Res. Inst.,A.R.C, Alex. Lab., Egypt
[2]Food Sciences Dept., Fac. Of Agric., Saba Bacha, Univ. of Alexandria, Egypt.

ABSTRACT: The present work was conducted to evaluate the effect of unblanched (U),steam blanched(SB), osmotic dehydration(OS) and microwave (MW) as pretreatments and convective air drying as well as freeze-drying (F) as drying methods to prepare pumpkin pulp powder. The proximate chemical composition, total, reducing and non-reducing sugars, dietary fiber, some bioactive compounds and antioxidant activities of pumpkin pulp powder were determined. The results showed that the moisture content of the dried pumpkin pulp could be arranged in a descending order as follow: microwave MW, SB, U, F and finally OS. The previous mentioned dehydration processes removed 86.44, 86.83, 88.75, 89.22 and 91.47% of the initial water content leading to final moisture content of 12.33, 11.97, 10.23, 9.8 and 7.75 %, respectively. Pumpkin pulp is considered as a rich source of some bioactive compounds. Carotenoids as β-carotene, polyphenols , flavonoids and ascorbic acid content were 24.73 mg /100g, 120.22 mg GAE / 100g, 24.73 mg RE / 100g and 181.21 mg / 100g on D.W, respectively. All treatments caused increment in β-carotene and polyphenol content except osmotic dehydration that caused pronounced decrement. Flavonoid content increased to reach 33.07 mg (rutin equivalent)RE/100g by steam blanching, while, all the other treatments caused decrement. Ascorbic acid was dramatically decreased by all treatments. Except the OS dehydration sample , the free radical scavenging activity by DPPH(1,1-Diphenyl-2picryl-hydrazyl) method varied between 49.7 in case of freeze drying to 69.34% in case of MW sample. On the other hand, IC_{50} values varied from 14.42 to 53.59 mg/ml.
Keywords: pumpkin, drying, chemical composition, carotenoids, flavonoids,   polyphenols, vitamin C, antioxidant activity.

INTRODUCTION

Pumpkin is originated from Latin America and domesticated in several tropical and subtropical countries (Chweya and Eyzaguirre, 1999 and Canico *et al*.,2005). Pumpkin is cultivated from Northern Mexico to Argentina and Chile and has spread to Europe, Asia (India and China) and Western America (Mohammed, 2004). In accordance with the botanical classification *Cucurbitaceae* is part of the Dicotyledoneae class, *Cucurbitales* team (Robinson and Decker-walters,1997). The family *Cucurbitaceae* consists of about 130 genera and 800 species(Saboo *et   al*., 2003). The main species being: *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo* and *Cucurbita mixta* as mentioned by Doymaz (2007). It is important to mention the Cucurbits family, which amongst others, includes pumpkin, melon, cucumber, watermelon and zucchini (Guine *et al*.,2011). Pumpkin fruits are vary greatly in shape, size and colour. Pumpkins, in general, feature orange or yellow colour; however, some varieties exhibit dark to pale green, brown, white, red and gray. Their colour is largely influenced by yellow-orange pigments in their skin and pulp. Its thick rind is smooth with light, vertical ribs. In structure, the fruit features golden-yellow to orange flesh depending on the polyphenolic pigments in it. The fruit has a hollow centre, with numerous small, off-white coloured seeds interspersed in a net like structure (Adhau *et al*., 2015).

The production of pumpkin is quite common in China, India, Ukraine, USA, Egypt, Mexico, Italy and Turkey (Dirim and Caliskan,2012). Pumpkins are regarded as valuable vegetables primarily because of the high carotenoid content, and the low energetic value. Hence, it has become a highly valued component of slimming diets. The component of pumpkin regulates metabolism, as well as exerts a detoxifying and slightly dehydrating effect. It is also believed to protect against occurrence of cancer in human as mentioned by Astorg (1997). Pumpkin is also rich in carbohydrate, pectin, mineral salts and vitamins (Wang *et al*., 2002). Pumpkin contains biologically active components that include polysaccharides, ρ-aminobenzoic acid, fixed oils, sterols, proteins and peptides (Caili *et al*., 2006).

As mentioned by Marek *et al*. (2008), pumpkins are good sources of carotenoids and some varieties are rich in pro-vitamin A , mainly α and β-carotene, Also, Kiruthiga and Krishnaprabha (2015) mentioned that pumpkin contains lots of antioxidant like vitamin A and C, as well as zinc and α-hydroxyl acids which help to reduce the signs of aging. Pumpkin is a valuable source of functional components mainly carotenoids , lutein , zanthin, ascorbic acid, phytosterols, selenium and linoleic acid which acts as antioxidant which are reported to prevent skin diseases, eye disorders and cancer.

A number of pretreatments can be applied depending on the food to be dried, its end use, and availability. Pretreatment of food materials which includes; blanching, sulphiting, osmotic dehydration, soaking in ascorbic acid before or on drying have been investigated to prevent the loss of colour by inactivating enzymes and relaxing tissue structure. This improves the effect of drying by reducing the drying time and gives the eventual dried products of good nutritional quality (Kingsly *et al*., 2007and Doymaz, 2010). Food dehydration is still one of the most relevant and challenging unit operations in food processing, although the art of food preservation through the partial removal of water content dates several centuries. Drying technology has evolved from the simple use of solar energy to current technology that includes , spray drying , drum drying, freeze-drying , osmotic drying, extrusion, fluidization, and the use of microwaves, radio frequency (RF), refractance window and hurdle technology(Vega-Mercado *et al*., 2001). Drying constitutes an alternative way to increase the consumption of pumpkin and allows its use during the off-season. Besides having long shelf life, dried products have some storage and transportation advantages (Dirim and Çalıskan, 2012). In literature, the combination of more than one method of dehydration was studied by many researchers to decrease energy cost and improve product quality and quantity (Ismail and Kocabay, 2016).

The objective of this investigation was to evaluate the quality of dried pumpkin pulp by different techniques. Steam blanched, osmotic dehydration and microwave were used as pretreatments, while, convective air and freeze-drying were used as drying methods. Chemical composition, some bioactive components and antioxidant activity were determined to evaluate the quality characteristics.

MATERIALS AND METHODS

Materials
Pumpkin fruits

Fresh and similar ripening pumpkin fruits were purchased, free from physical defected, from central market of vegetables and fruits, Alexandria Governorate, Egypt.

Chemicals

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

Methods
Sample preparation of pumpkin pulp

Fig.(1) illustrates the preparation of pumpkin fruit pulp powder by different technological methods .Pumpkin fruits were carefully washed by tap water, drained, dried with a soft cloth and cut into halves. The pulp was purified from funicular part, spongy portion containing seeds, then was washed thoroughly with distilled water, then drained. The pumpkin fruit halves were manually peeled and cut into pieces using stainless steel knives based on the following dimensions 3 cm length, 1.5 cm width and 1.5 thickness. The pieces were placed into plastic bags to avoid contact with oxygen, then divided to five portions. The first and the second portions were pre-treated by steam blanching and osmotic drying, respectively. Steam blanching portion and osmotic drying portion were mashed using a blender (Moulinx , France) and continued dehydration by convective air dryer. The three other portions were mashed and dehydrated using convective, freeze- drying and microwave methods. The microwave dehydrated portion was continued dehydration using convective air dryer. The affomentioned pretreatments and all the drying methods were as follows:-

Pretreatments

The pumpkin fruits pulp was pretreated before dehydration by three methods : steam blanching (SB) , osmotic dehydration (OS) and microwave dehydration.

Steam blanching (SB)

The pumpkin pulp pieces were steamed over boiling water for 5 min to inactivate polyphenol oxidase. The blanched pumpkin pulp pieces were removed, cooled with air and excess water was blotted with tissue paper. The steam blanched pumpkin pulp was mashed and dehydrated using convective air dryer.
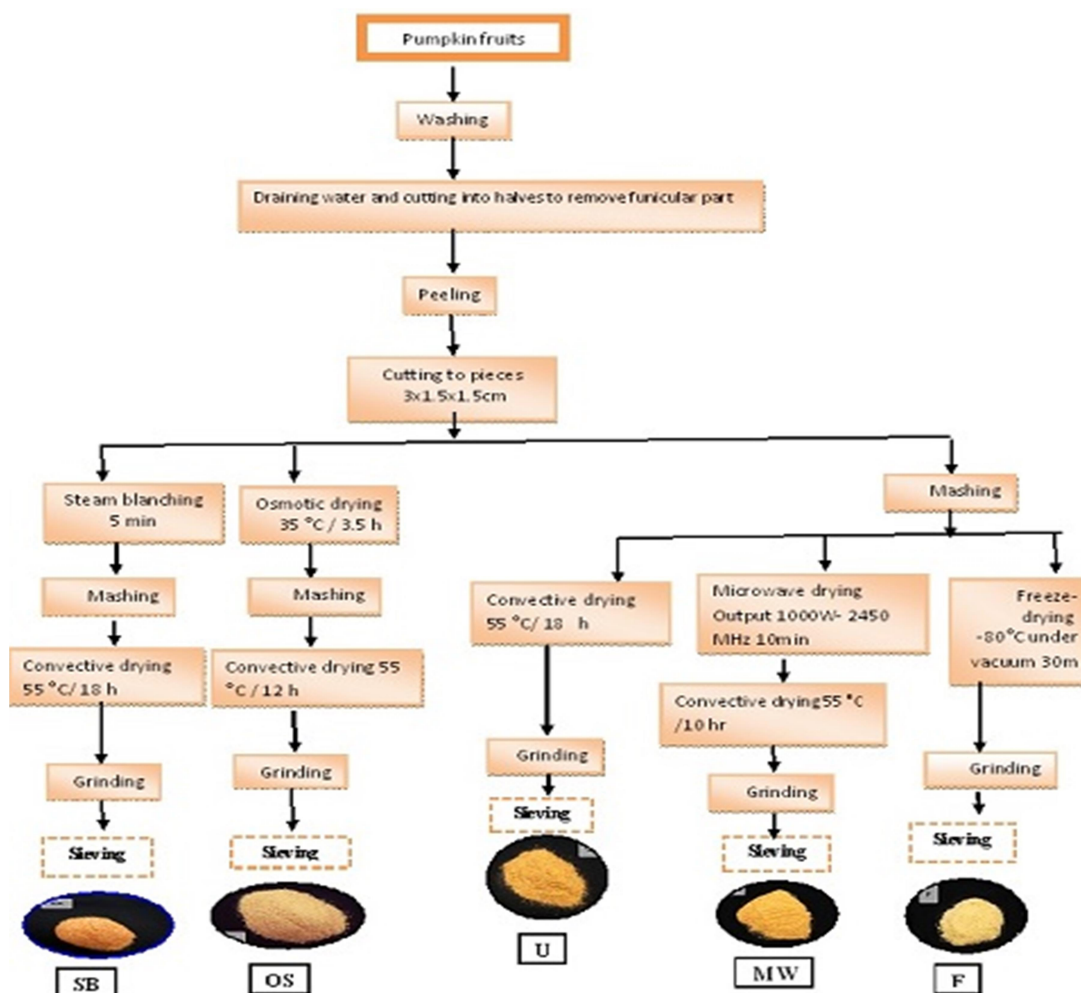
Fig. (1): Preparation of pumpkin fruit pulp powder by different drying technological Methods.

Osmotic dehydration (OS)

In order to select the proper conditions for osmotic dehydration, pumpkin pieces were osmotic treated according to the method described by Lee and Lim (2011) with some modifications. Three factors at three levels were employed and the independent variables were: sucrose/pumpkin pulp%(25,45 and 60%w/w), temperature of this mixture (35,50 and 65ºC) and time (210,150 and 90 min),respectively. The critical ranges of selected parameters were determined by preliminary experiments based on the literature review as mentioned by previous authors. After the osmotic dehydration of the three samples of the preliminary experiment, the samples were withdrawn from the formed solution and gently blotted with tissue paper to remove adhering sugar solution.

The sensory evaluation was carried out to select the preferable conditions of osmotic dehydration as pretreatment for drying of pumpkin pieces. The preferable conditions of osmotic dehydration according to sensory evaluation were 35 ºC temperature, 3.5 h immersion time and 25% w/w sucrose /pumpkin pulp. After osmotic dehydration by the preferable conditions, pumpkin pulp was cooled, mashed and dehydrated by convective air dryer at 55ºC for 12 h.

Microwave drying (MW)

The drying experiments were carried out in a domestic microwave oven (Hyundai HY-1038S,China). Microwave oven has a maximum output power of 1000w at 2450MHz. The adjustment of processing time was done with the aid of a digital control apparatus located on the microwave oven. The area subjected to microwave drying consists of a rotatable plate which is 30 cm in diameter fitted inside the microwave oven cabinet.

Preliminary experiment was done to select the suitable time for microwaving pumpkin pulp. Raw mashed pumpkin pulp samples (200 ± g2 for each sample) were spreaded on the rotatable plate, then dried for different times ranged from 8 to 12 min. Ten min was the most suitable time for drying pumpkin pulp according to moisture content (82%) and colour. The drying was completed in convective air dryer as mentioned previously.

Drying Methods

Pumpkin fruit pulp was dried using two pretreatments and three drying methods: Unblanched convective air drying (U) ,steam blanched convective air drying (SB), Osmotic dehydration followed by convective air drying (OS), freeze-drying (F) and microwave dehydration followed by convective air drying (MW).

Convective air drying

Mashed, mashed steam blanched, mashed osmotic dehydrated and microwave dehydrated pumpkin pulp were spreaded on stainless steel trays coated with thin film oven bags and dried in convective air dryer at 55ºC for 18,18 , 12 and 10h, respectively.

Freeze-drying (F)

The experiments were performed in the Central laboratory, Faculty of Agriculture, Alexandria University using freeze-dryer (Freezoneplus 6, Labconco made , USA).The mashed pumpkin was frozen in a layer of 5mm in the healthy aluminum foil dishes at - 40 °C in an air blast freezer for two h, then freeze-dried under vacuum (30m torre absolute pressure), at - 80 °C condenser temperature for 53 h. The temperature of the heating plate was set to +30 °C which accelerated the sublimation process and it was constant during the drying process. The powder of all pumpkin dried samples were obtained after cooling by grinding the dried material using an electrical mill (SEB 21260 France) to pass through 60 mesh sieve. The resulting powder was kept in an airtight container and stored at -18 °C until used.

Physical methods
Fruit weight composition

An average weight (g) of 20 pumpkin fruits was determined . The rind, pulp and funicular, the spongy portion including seeds, were manually separated using stainless steel knives, then weighed and calculated as % of an average fruit weight using an electronic balance reading to 0.001g.

Chemical methods

Chemical methods for fresh pumpkin and pumpkin powder (U, SB, OS, F and MW) were estimated as follows: -

Proximate composition: 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 according to the following equation:

NFE= 100-(%crude protein + %crude ether extract+ %crude fiber + %total ash)

Total, reducing and non-reducing sugars: Total sugars were determined as invert sugars according to the titrametric method of Lane and Eynon after acid hydrolysis as described in the AOAC (2007).Reducing Sugars were determined in the lead free filtrate before inversion using Lane and Eynon as described in the AOAC (2007). Non-reducing sugars as sucrose were calculated as sucrose according to the following equation:

Non-reducing sugars % = (total sugars% - Reducing sugars %)×0.95.

Dietary fiber: The dietary fiber fractions including neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the methods of Goering and Van Soest (1970). While percentage of hemicelluloses and cellulose were calculated according to the following equations:-
% hemicelluloses= %NDF-%ADF .
 % cellulose =%ADF-%ADL

Total phenolic content: The total phenolic content was estimated using the Folin-Ciocalteu´s reagent according to the method of Maurya and Singh (2010). Gallic acid was used as a standard and the total phenolic were expressed as mg gallic acid equivalent (GAE/100g). 1mg/ml of sample extract was prepared , then 0.5 ml of each sample were introduced into test tubes and mixed with 2.5 ml of a 10 fold dilute Folin-Ciocalteu reagent and 2ml of 7.5% sodium carbonate. The tubes were covered with paraffin film and allowed to stand for 30 min at room temperature before the absorbance was measured at 760 nm spectrophotometrically.

Total flavonoid content: Flavonoid content of samples was extracted by 80% methanol and measured using aluminum chloride according to the method of Olajire and Azeez (2011). Rutin was used as a standard and flavonoid contents were measured as rutin equivalent (RE). 1ml of extract was taken into 10ml volumetric flask, containing 4 ml of distilled water and 0.3 ml of 5% $NaNO_2$ were

added to the flask. After 5 min, 0.3 ml 10% AlCl$_3$ was added to the mixture. At the 6th min , 2 ml of 1M NaOH was added and the volume was made up to 10 ml with distilled water. The absorbance was measured spectrophotometrically at 510 nm.

Antioxidant activity:

DPPH radical scavenging activity: Antioxidant activity of samples were measured by evaluating the free radical scavenging activity of the 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) radical according to a modified method by Brand-Williams *et al*. (1995). Briefly, 0.3 ml methanolic extract was added to 2.7 ml DPPH 0.1 mmol in methanol solution. The reaction mixture was vortex–mixed well and incubated for 30 min at room temperature in the dark. Absorbance was measured spectrophotometrically at 517 nm. The antioxidant activity was expressed as % of inhibition of DPPH radical and calculated from the equation:

Inhibition (%) = [(A DPPH – A sample)/ A DPPH] x 100

A sample is the absorbance of sample.
A DPPH is the absorbance of the control (DPPH solution).
The IC$_{50}$ is defined as the concentration of antioxidant necessary to decrease the initial DPPH concentration by 50%. The IC$_{50}$ of the samples was derived from the % scavenging activity vs. concentration plot and is expressed as mg/ml.

Ferric reducing antioxidant power (FRAP) assay: The reducing power was determined according to the method of Oyaizu (1986). Various concentrations of sample methanolic extracts (2.5 ml) were mixed with 2.5 ml of 200 mmol/l sodium phosphate buffer (pH 6.6) and 2.5ml of 1% potassium ferricyanide. The mixture was incubated at 50ºC for 20 min. After, 2.5 ml of 10% trichloroacetic acid (w/v) were added, the mixture was centrifuged at 3000 rpm for 10 min. The upper layer (5 ml) was mixed with 5 ml deionised water and 1 m1 of 0.1% of ferric chloride and the absorbance was measured at 700 nm. Higher absorbance indicates higher reducing power. The assay was carried out in triplicate and the results are expressed as mean value ± SD.

Carotenoids as β- carotene: Total carotenoids were determined by a modified method of Ranganna (1977) using acetone and petroleum ether as extracting solvent and the absorbance was measured at 450nm.

Ascorbic Acid: Ascorbic acid was determined according to Ranganna (1977) method using 2,6 dichlorophenolindophenol dye.

Statistical analysis: The data were subjected to statistical analysis using analysis of variance (ANOVA). The average values (mean± SD) were compared by using least significant differences test (LSD- test) as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Fruit weight composition of pumpkin:

Fruit weight composition of pumpkin and the % of each portion are presented in Table (1). The average weight of pumpkin fruit was 5.46 kg. The results obtained in the present study are not in accordance with those found by Naser *et al*. (2002), Dhiman *et al*. (2009) ,Oyekunle and Abosede (2012) and Niewczas *et al*. (2014) . They found that the average weight of pumpkin fruit varied between 2.05 to 3.95 Kg. On the other hand, Mahmoud (2009) found that the average weight of pumpkin fruit was 6.15 kg. Pumpkin fruit composed of 4.65 kg pulp, 0.46 kg peel and 0.35 kg funicular part (0.21kg spongy portion and 0.14 kg seeds). These values mean that the yield of fruit pulp (pulp recovery) was relatively high and represents 85.18% of total fruit weight . Pulp recovery found in the present study is in accordance with that stated by Samaha (2002) (85.54%) and relatively close to that mentioned by Naser *et al*. (2002) (81.30%) and higher than that found by Dhiman *et al*. (2009) (76.7%). The ratio of pulp: peel: seed was 32.4 :3.2 :1, while that mentioned by Naser *et al*. (2002), Dhiman (2009) and Mahmoud (2009) was 20.9:1.2:1.0 ,   38.6:1.5:1.0   and 23:6:1 , respectively.

Table (1). Fruit weight composition of pumpkin

Property	Value[*]	(%)
Average fruit weight(kg)	5.46±0.48	
Fruit weight composition:-		
Peel (g)	456.5 ±0.32	**8.37%**
Pulp (g)	4647 ±1.04	**85.18%**
Funicular part (g)	352.00 ±0.84	**6.45%**
Spongy portion (g)	208.50 ±0.63	**3.82%**
Seeds(g)	143.50±0.18	**2.63%**
Pulp :peel : Seed	32.4:3.2:1	------

[*] Mean ±SD.

Chemical Composition of pumpkin pulp as affected by different pretreatments and various drying methods:

The data in Table (2) present the mean values of chemical composition of fresh pumpkin pulp and after different pretreatments and dehydration methods. Moisture of fresh pumpkin pulp was the main component of the pulp being 90.90%. This value is in accordance with that mentioned by Naser *et al*. (2002), Pongianta *et al*.(2006), Mahmoud(2009), Fedha (2010), Henriques *et al*.(2012) and Adubofour *et al*.(2016). They mentioned that moisture content of fresh pumpkin pulp varied from 84.32 to 95.66%.This value decreased by various dehydration methods. The lowest value (7.75%)was obtained by OS. The moisture content of the dried pumpkin pulp could be arranged in descending order as follows: MW, SB, U, F and finally OS. The previous mentioned dehydration processes removed 86.44, 86.83, 88.75, 89.22 and 91.47% of the initial moisture content leading to final moisture content of 12.33,

11.97, 10.23, 9.8 and 7.75 %, respectively. From the statistical point of view, no significant differences were noted between moisture content of SB and MW, while, significant differences were existed in the mean values of moisture content of all the other treatments.

Table (2). chemical composition of pumpkin pulp as affected by pretreatments and various drying methods (on dry weight basis)

Component[*] %	Fresh	Drying methods					L.S.D
		U	SB	OS	F	MW	
Moisture	90.90[a] ±0.95	10.23[c] ±0.23	11.97[b] ±0.98	7.75[d] ±0.75	9.8[c] ±0.69	12.23[b]±0.98	1.364
Crude protein (CP)	11.43[a]±1.62	11.05[a]±1.1	10.88[a]±2.83	4.14[b]±0.64	11.31[a]±2.12	11.157[a]±2.67	3.098
Crude ether extract (CEE)	8.02[a]±0.27	8.13[a]±0.14	8.19[a] ±0.31	3.78[b] ±0.77	8.02[a] ±0.44	7.76[a]±0.51	0.898
Crude fiber (CF)	13.74[ab] ±0.43	13.48[ab] ±0.47	13.93[a] ±0.49	6.24[c]±0.42	13.09[b] ±0.3	13.92[b]±0.48	0.838
Ash	17.25[a]±0.19	16.74[ab] ±0.52	16.15[b]±0.6	3.58[d] ±0.43	17.23[a] ±0.35	14.32[c]±0.69	0.613
NFE[**]	49.56[b]±4.03	50.60[b]±3.59	50.85[b]±2.62	82.26[a]±3.07	50.35[b]±3.09	52.84[b]±2.93	6.169

[*] Mean ± SD of triplicate analysis. LSD: Least significant differences.
[**] Nitrogen free extract (NFE) = Calculated by deference.
Mean in a row not sharing the same letter are significantly different at p ≤0.05.
U: Unblanched.SB: Steam blanched. OS: Osmotic. MW: Microwave. F: Freeze-drying.

Osmotic dehydration method had the highest effect on all components .The transfer of sucrose, as osmotic solute, into pumpkin pieces and the water from the pumpkin pieces to the osmotic medium during dehydration process at 35ºC for 3.5 h as pretreatment were possibly the reason of the reduction in crude protein(CP) , crude ether extract(CEE)**,** crude fiber (CF) and the increment of NFE. Also, the leaching out of some soluble constituents into the osmotic dehydration medium may be another cause of the reduction in the previous mentioned components. The same observation was previously remarked by Torreggiani and Bertolo (2004), Araya-Farias *et al*. (2014) and Nowicka *et al* .(2015). CP, CEE and CF content of fresh, U, SB, F and MW samples were very close to each other. This means that steam blanching and microwave before convective air dehydration and freeze- drying had the lowest effect on the studied pumpkin pulp constituents.

From the statistical point of view, there were high significant differences between the chemical composition components of OS treatment and the other treatments. Also, statistical analysis declared that there were no significant differences in CP,CEE and CF between fresh pulp and those of U,SB,F and MW powders . For ash content, no significant differences were noted between fresh, U,F treatments, while, SB and MW showed significant differences .

Sugar content:

Values of total, reducing and non-reducing sugars found in fresh and dried pumpkin pulp are presented in Table (3). Fresh pumpkin pulp had 33.19, 10.66 and 21.41% D.W. total, reducing and non-reducing sugars, respectively. Henriques *et al*. (2012) found that total, reducing and non-reducing sugars were 43.78,24.61 and 14.47 %, respectively. On the other hand , Sharma and Rao (2013) found that these values were 90.13, 77.30 and 13.73 mg/g F.W for total , reducing and non- reducing sugars, respectively.

Table (3). Sugar contents of pumpkin pulp as affected by pretreatments and various drying methods (on dry weight basis)

Component* %	Fresh	Drying methods					L.S.D
		U	SB	OS	F	MW	
Total sugars	33.19^b±2.97	30.95^{bc}±2.4	28.23^c±2.78	55.71^a±2.83	32.99^b±1.96	31.90^{bc}±2.79	4.044
Reducing sugars	10.66^b±1.77	10.55^b±1.56	9.96^b±2.03	2.34^c±0.23	10.62^b±1.47	14.13^a±1.87	2.5433
Non reducing sugars	21.41^b±2.16	19.38^{bc}±2.47	17.36^{bc}±2.65	50.70^a±1.32	21.25^b±2.79	16.88^c±2.13	4.3683

* 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.
U: Un blanched. SB: Steam blanched. OS: Osmotic. MW: Microwave. F: Freeze- drying.

The results obtained in the present study showed that there was noticeable change in the content of sugars owing to the treatments .U, SB, MW methods caused slight decrement in total sugars being 30.95,28.23 and 31.90 %, respectively, while, F had very close value to the fresh pumpkin (32.99%). OS caused 55.71% increment .This increment may be due to the sucrose added to pumpkin pulp during osmotic dehydration for 3.5 h.

Reducing sugars content of U, SB and F were very close to the fresh pulp. The highest effect was observed in OS and MW treatments. As for non-reducing sugars, OS treatment caused high increment, while, U, SB and MW caused decrement. Freeze- drying method had the same value (21.25%) as fresh pulp.

Statistically, high significant differences were noted between OS and all the other treatments in their sugar content. while, there were no significant differences between fresh, U and F treatments in their content of total, reducing and non-reducing sugars. The values of sugar content and the statistical analysis revealed that freeze- drying technique had the nearest values to fresh pumpkin.

Guine *et al*. (2011) reported that total, reducing and non-reducing sugars were 17.0, 14.6 and 2.3% , respectively, when pumpkin dried at 70ºC. Filho *et al*. (2011) found that total sugars were 50.87% and 43.25% on D.W. for fresh and blanched pumpkin pulp. Henriques *et al*.(2012) reported that total ,reducing and non-reducing sugars for pumpkin after air drying at 60ºC were 17.62,15.31, and 1.97 % D.W. , while ,the values were 28.02 ,16.46, and 10.99 % D.W after freeze- drying, respectively.

Dietary fiber fractions:

Dietary fiber fractions of fresh and dried pumpkin by different techniques are presented in Table (4) .The fractions and their values on DW in fresh pumpkin pulp were 15.41, 14.53, 0.88, 11.44% and 3.09%for neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, acid detergent lignin (ADL), and cellulose. The previous mentioned values on D.W corresponding 1.40% NDF, 1.32% ADF, 0.08% hemicellulose, 1.04% ADL and 0.28% cellulose on F.W. The values of NDF and ADF are within the range that found by Nawirska *et al*. (2008).

Generally, the present study showed that the highest effect was observed in OS treatment that caused pronounced decrement in all fractions, owing to the gain of sucrose and the leaching out of soluble constituents. As for the other four treatments, slight decrement of ADL in SB and MW was observed. The values of NDF in the five pumpkin pulp powder samples were lower than that found by Kulaitienė *et al*. (2014) and Cerniauskiene *et al* .(2014) that ranged between 18.80 to 21.27% and between 16.40 to 26.50% DW, respectively. The contents of ADF in U, SB and MW treatments were within the values that recorded by Cerniauskiene *et al*. (2014) in ten cultivars (between 10.12 to 24.65% D.W), while, its content in OS and F is lower. The values of hemicellulose of the dried five samples are in the lower range found by Cerniauskiene *et al*. (2014) (0.70 to 14.18% DW), while, ADL% are in accordance with the range that found by the same previous author (0.86 to14.35%).Lignin is more closely related to cellulose than to hemicellulose and has greater effect on its digestion (Van- Soest *et al*., 1991),Also, Saha(2003) reported that a big amount of lignin is an undesirable component in NDF fiber, since it reduces other fibers, hemicellulose and cellulose, degradation .Also, Cerniauskiene *et al*. (2014) mentioned that it might be thought that lower lignin content in pumpkin flour would make it easier for the human organism to absorb the cellulose and hemicellulose. Cellulose content found in the present study was lower than that recorded by Cerniauskiene *et al*. (2014) (8.31 to 11.51%). The previous authors concluded that flour obtained from pumpkin fruits could be recommended as the component suitable for food production with high content of dietary fiber.

Table (4). Dietary fiber fractions (%) of pumpkin pulp as affected by pretreatments and various drying methods (on dry weight basis)

Component* %	Fresh	Drying methods					L.S.D.
		U	SB	OS	F	MW	
Neutral detergent fiber (NDF)	15.41[a]±4.2	15.08[a]±1.64	13.47[a]±3.19	7.15[b]±3.8	15.11[a]±2.00	15.63[a]±3.00	6.059
Acid detergent fiber (ADF)	14.53[a]±1.66	14.16[a]±2.61	13.13[a]±2.75	6.30[b]±1.29	14.57[a]±2.74	14.46[a]±2.51	4.562
Hemicelluloses' (NDF-ADF)	0.883[b]±0.22	0.923[b]±0.28	0.343[d]±0.06	0.85[b]±0.14	0.54[c]±0.05	1.17[a]±0.18	0.1662
Acid detergent lignin(ADL)	11.44[a]±1.56	11.25[a]±2.86	9.32[a]±3.7	3.57[b]±1.55	11.27[a]±3.17	10.53[a]±2.58	5.354
Cellulose	3.09[a]±0.21	2.91[a]±1.03	3.81[a]±1.3	2.73[a]±0.75	3.30[a]±1.65	3.93[a]±1.08	2.1822

* 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.
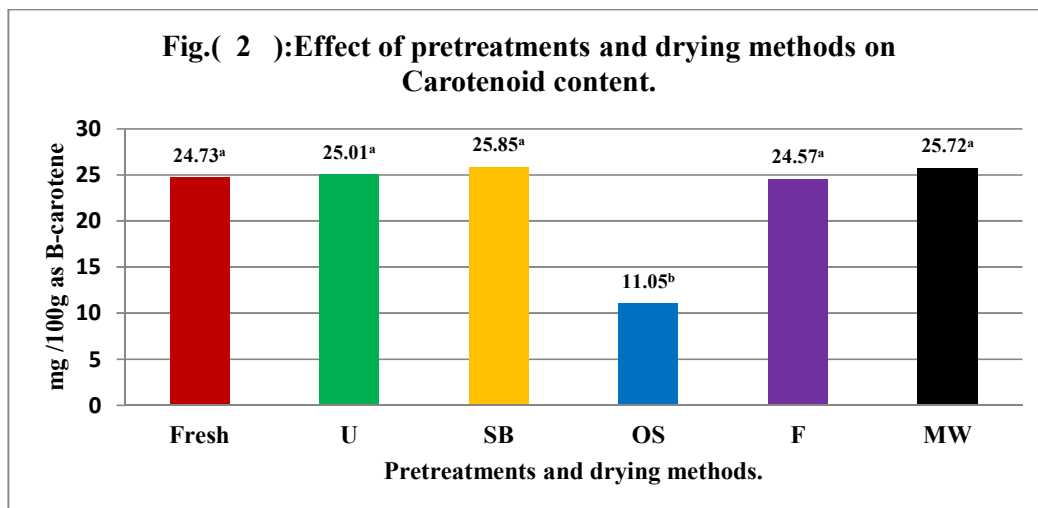U: Un blanched. SB: Steam blanched. OS: Osmotic. MW: Microwave. F: Freeze -drying.

Statistical analysis indicated that there were pronounced significant differences in OS and all the other treatments in their contents of NDF, ADF and ADL, while, there were no significant differences between all the treatments in cellulose content. Also, there were no significant differences in fresh, U,SB, F and MW in their contents NDF, ADF and ADL content. As for hemicellulose, no significant differences were noted in fresh, U and OS treatments, while, SB,F and MW had significant differences between each other and the other treatments.

Bioactive components
Pumpkin fruit pulp can be considered as a good sources of some bioactive components. Heat processing of plant material generally results in the loss of biologically active **compounds (Divya *et al*., 2012). The values of carotenoids, polyphenols, flavonoids and ascorbic acid found in fresh and dried pumpkin pulp by various drying techniques are presented in Fig .(2,3,4 and 5).** Fresh pumpkin pulp had 24.73 mg/100g,120.22 mg GAE/100g, 24.73 mg CE/100g and 181.21 mg/100g DW carotenoids as β- carotene, polyphenols, flavonoids and ascorbic acid, respectively.

Carotenoids

The content of carotenoids as β -carotene in fresh and dried pumpkin pulp as affected by different pretreatments and dried methods are shown in Fig. (2).

Fig.(2):Effect of pretreatments and drying methods on Carotenoid content.

The initial content was 24.73 mg/100g D.W, corresponding to 2.25 mg/100g(F.W), which is very close to that found by Pongjanta *et al* .(2006) (2.43mg/100g), Bhat and Baht (2013) (2.461mg/100g), Kulaitiene *et al*. (2014) that ranged between 1.86 to 2.44 mg/100g and Tamilselvi and Jansirani (2017) that ranged between 0.3 to 3.00 mg/100g F.W. On contrast, the value was higher than that mentioned by Mala *et al*. (2016) (1.07 mg/100g F.W) and lower than that found by Pandey *et al*. (2003) (2.34 to 14.85 mg/100g F.W),Dhiman *et al*. (2009) (11mg/100g F.W),Jaeger de Carvalho *et al*. (2014) (17.2 mg/100g F.W), Zdunic *et al*. (2016) (8.6 mg/100g F.W) and Achilonu *et al*. **(2017)** (1.48 to 17.04 mg/100g F.W). According to De Pee (1996), carotene fruits and pulpy vegetables, such as pumpkin, are considered to be better absorbed than those from dark green leafy vegetables.
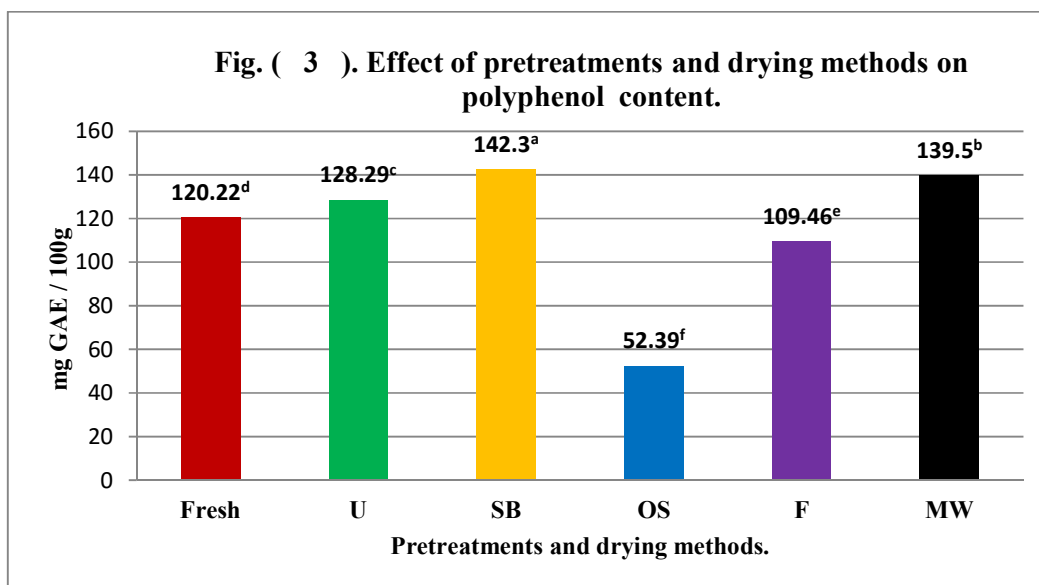
The effect of the processes used in the present study could be summarized as follow : slight increment after U (+ 1.13%),MW(+4%) and SB (+4.52%) and pronounced decrement after OS (-55.32%) while, freeze- drying had neglected effect. The highest effect on carotenoid content of pumpkin pulp was due to OS method. The increment that was noted after U (25.01 mg/100g DW), MW (25.72mg/100g D.W) and SB (25.85 mg/100g D.W) drying may be due the increment of carotenoid bioavailability by heat.

Van het Hof *et al*. (2000), Fernandez-Garacia *et al*. (2012) and Jaeger de Carvalho *et al*.(2014) reported that in general, processing of vegetables resulted in breakdown of the cellulose structure of the plant cell and thus improves the bioavailability of carotenoids and sometimes even the carotene content can increase .Kulaitiene *et al*. (2014) stated that the most notable positive effect of processing (dried pumpkin flesh slices at 60 ºC) on the overall quality or health capacity of food is the increased bioavailability of β-carotene

resulting in an increased antioxidant status. Also, Rodrigues-Amaya and Kimura (2004) mentioned that blanching is an important thermal treatment that inactivates oxidative enzymes that would degrade carotenoids.

Polyphenols

Fig. (3) illustrates the polyphenol content of fresh pumpkin pulp and the dried five treatments. Total polyphenol content for fresh pumpkin pulp was

Fig. (3). Effect of pretreatments and drying methods on polyphenol content.

120.22 mg GAE/100g D.W and is lower than that mentioned in previous studies. It was about half the amount found by Nawirska-Olszanska *et al*. (2011)(205.74 mg/100g DW). Also, the values obtained in the present study was very far to the values reported by Dirim and Caliskan (2012) (225.22mg GAE/g DW), Sharma and Rao (2013)(11.35mg/100g FW), Zdunic *et al* .(2015)(905.9 µg GAE/g F.W)and Mala and kurian (2016)(5.21 mg GAE/g F.W) .The phenolic and flavonoid content of plants whether organically or conventionally cultivated is influenced by several factors such as variety, seasonal variation, light and climate, degree of ripeness, and food preparation and processing(Aherne and O´Brien, 2002). Synthesis by plants of phytochemicals is also partly related to insect and microorganism pressures .The differential use of pesticides and fungicides may therefore influence phenolic compound and flavonoid content (Dixon,1995).Also, Dirim and Caliskan (2012) mentioned that the different extraction processes may be the reasons for the differences between the determined values of total phenolic contents.

The results obtained in the present study showed noticeable change in the content of polyphenols owing to the pretreatments and drying methods. SB, MW and U drying methods caused increment, while F and OS caused decrement in this content. The increment was about 18, 16 and 7 % for SB, MW and U, respectively. The highest increment was in SB (142.30 mg GAE/100g D.W) followed by MW (139.5 mg GAE/100g D.W) . This may be due to the inactivation of polyphenol oxidase enzymes during processing. It had been showed that thermally processed foods, especially fruits and vegetables, exhibited higher biological activities due to various chemical changes undergone during heat treatment (Dewanto *et al*., 2002). The decrements of polyphenols were about 56 and 9% for OS and F, respectively. The decrement during OS process may be due to the release of polyphenols with water loss as water soluble component during osmotic drying for 3.30 h, as well as the thermal degradation during the convective air drying for 12 h. Freeze- drying method reduced the polyphenols by 9% , while, Dirim and Caliskan (2012) recorded lower reduction (3%). Shofian *et al*. (2011) expressed significant differences for the amounts of total phenolic content between the fresh and freeze-dried fruit samples (starfruit , mango, papaya, watermelon). In their study, freeze- drying process caused total phenolic content losses of 24, 23, 40 and 48% for star fruit, mango, papaya and watermelon, respectively.
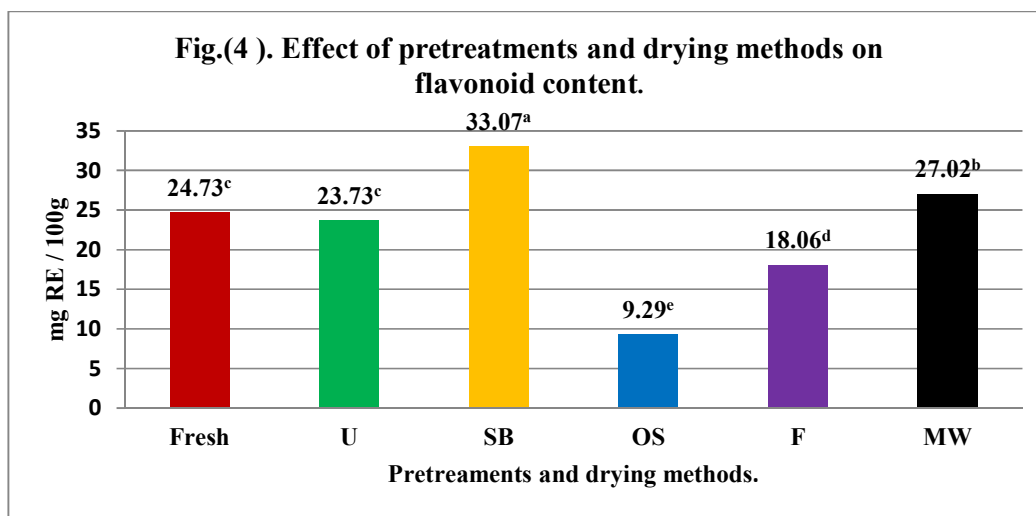
Statistically, there were significant differences between the values of polyphenols found in fresh and all the dried samples and also between the five treatments.

Flavonoids

Flavonoid content found in fresh and dried pumpkin pulp is presented in Fig. (4). Fresh pumpkin pulp had 24.73 mg RE/100g D.W. The average value reported by Javaherashti *et al*. (2012) found that flavonoid content of four genotypes of winter pumpkin was about 25.24 mg QE/g F.W. On the other hand, Chottanom *et al*. (2014) and Ali (2015) found that total flavonoid contents were 29.39 mg CE *l*100g and17.24 QE/kg F.W, respectively.

The data in Fig. (4) showed slight loss of flavonoids due to U (23.73 mg RE/100g D.W), while, F (18.06 mg RE/100g D.W) and OS (9.29 mg RE/100g D.W) show high decrement. On contrast, SB (33.07mgRE/100g) and MW (27.02 mg RE/100g) caused increment. Chottanom *et al*. (2014) recorded that flavonoid content increased after osmotic dehydration from 29.39 mg CE *l*100g as initial value to 45.91 mg CE/100g and 45.91 mg CE/100g for 30 and 60 min osmotic dehydration , respectively.

Statistical analysis revealed that there were no significant differences between fresh and U treatment, while, high significant differences were found between all the other treatments.

Fig.(4). Effect of pretreatments and drying methods on flavonoid content.

A bar chart titled "Fig.(4). Effect of pretreatments and drying methods on flavonoid content." with y-axis "mg RE / 100g" ranging from 0 to 35 and x-axis "Pretreaments and drying methods." showing: Fresh = 24.73^c, U = 23.73^c, SB = 33.07^a, OS = 9.29^e, F = 18.06^d, MW = 27.02^b.
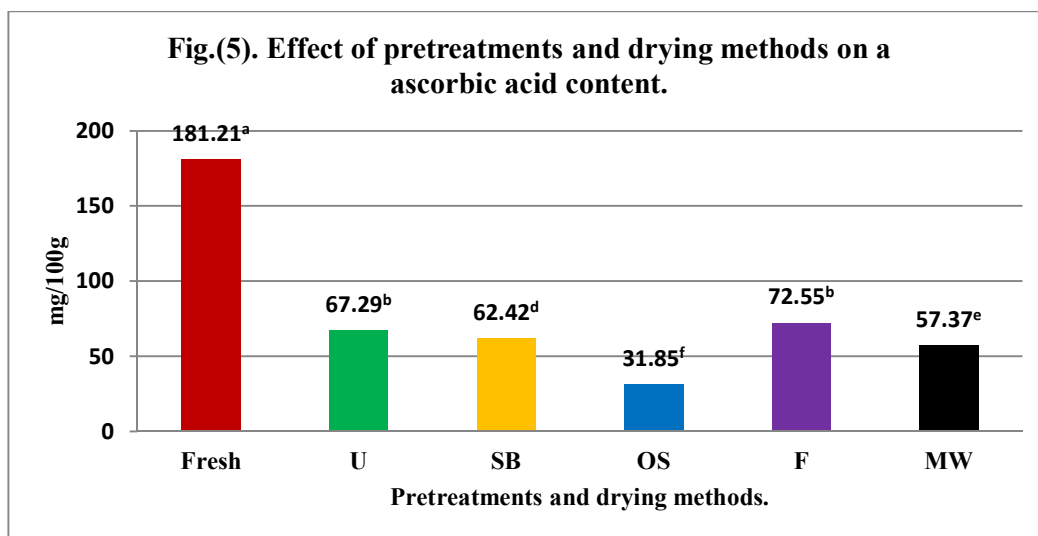
Ascorbic acid

As seen in Fig. (5), the concentration of ascorbic acid in fresh pumpkin pulp was 181.21mg/100g D.W corresponding to 16.49 mg/100g F.W. This value is in accordance with the range mentioned by Biesiada *et al*. (2011) and Nawirska-Olszanska *et al*. (2011) . They found that ascorbic acid varied between 1.36 and 42.48 mg/100g FW, and was lower than range found by Biesiada *et al*. (2009) (between 22.1 and 31.5mg/100g). In contrast, it was higher than that found by Pandey *et al*. (2003) (between 1.53 and 6.74 mg/100g FW),Dhiman *et al*. (2009) (14.5mg/100g FW),Dirim and Caliskan (2012) (20.20mg/100g DW),Henriques *et al*. (2012) (127.04mg/100g DW) and Sharma and Rao(2013) (11.35 mg/100g FW).

The same Fig.(5) showed pronounced effect on the content of vitamin C of all the pretreatments and the different drying methods.

All the treatments caused high reduction in this vitamin . The treatments can be ranked in descending order according to the reduction as follow: OS, MW,SB,U and finally F. The reduction represented 82.42, 68.35, 65.55, 62.27 and 59.96% respectively .The highest reduction was in OS and the lowest was in freeze drying method.

Fig.(5). Effect of pretreatments and drying methods on a ascorbic acid content.

Vitamin C is water soluble, very sensitive to high temperature and in the presence of oxygen in air, reacts and is oxidized. During the OS method, ascorbic acid could be lost in osmotic medium in addition to the thermal process of the osmotic dehydration at 35 ℃ for 3.5 h followed by the convective air drying at 55 ℃ for 12 h.

The reduction in ascorbic acid by SB (65.55%) method was very close to that happened by U (62.87%), which may be due to the steam blanching before dehydration. Gliguem and Birlouez-Aragon (2005), Vikram *et al* .(2005) and Cruz *et al*. (2008) reported that in all drying treatments, vitamin C contents decreased drastically.

As for freeze- drying process, Henriques *et al*. (2012) recorded a higher reduction in ascorbic acid (89.18%), while, Dirim and Caliskan (2012) found a very low reduction (18.02%).This may be due to the conditions of the drying process. Also, Marques *et al*. (2011) mentioned that vitamin C losses can be due to not only the freeze-drying, but also by the operations before drying such as cutting, slicing and freezing. Therefore, grinding process may cause more vitamin C losses for the pumpkin pulp. Vitamin C losses for freeze-dried fruits are considerable smaller when compared to the vitamin C losses caused by other drying methods due to the low temperatures and to the use of vacuum process.

Statistical analysis showed the same observation, that there were high significant differences between all the samples.

Antioxidant activity

Antioxidant activity of vegetables is very important quality characteristics from nutritional attitude (Javaherashti *et al*.,2012) due to the deleterious role of free radicals in foods and in biological system (Gulci *et al*.,2012). Antioxidant activity was determined using two different methods namely DPPH and ferric reducing antioxidant power (FRAP) for the methanolic extract of fresh and dried pumpkin pulp powder by various pretreatments and drying methods.

DPPH radical scavenging activities

Fresh and dried pumpkin pulp extracts radical scavenging activities, expressed as % DPPH values, are present in Fig. (6a)and IC_{50} (6b). The antioxidant capacity of fresh pumpkin pulp (23.04% DPPH) was lower than that recorded by Javaherashti *et al.* (2012) (54.4% DPPH). After drying process, the reduction in radical scavenging activity among the dried samples could be ranked in descending order as follows: maximum reduction was found in MW (69.34%), followed by SB (66.70%), U (55.97%),F(49.70%) and finally OS(18.66%). It was observed that all the drying methods caused an increment.
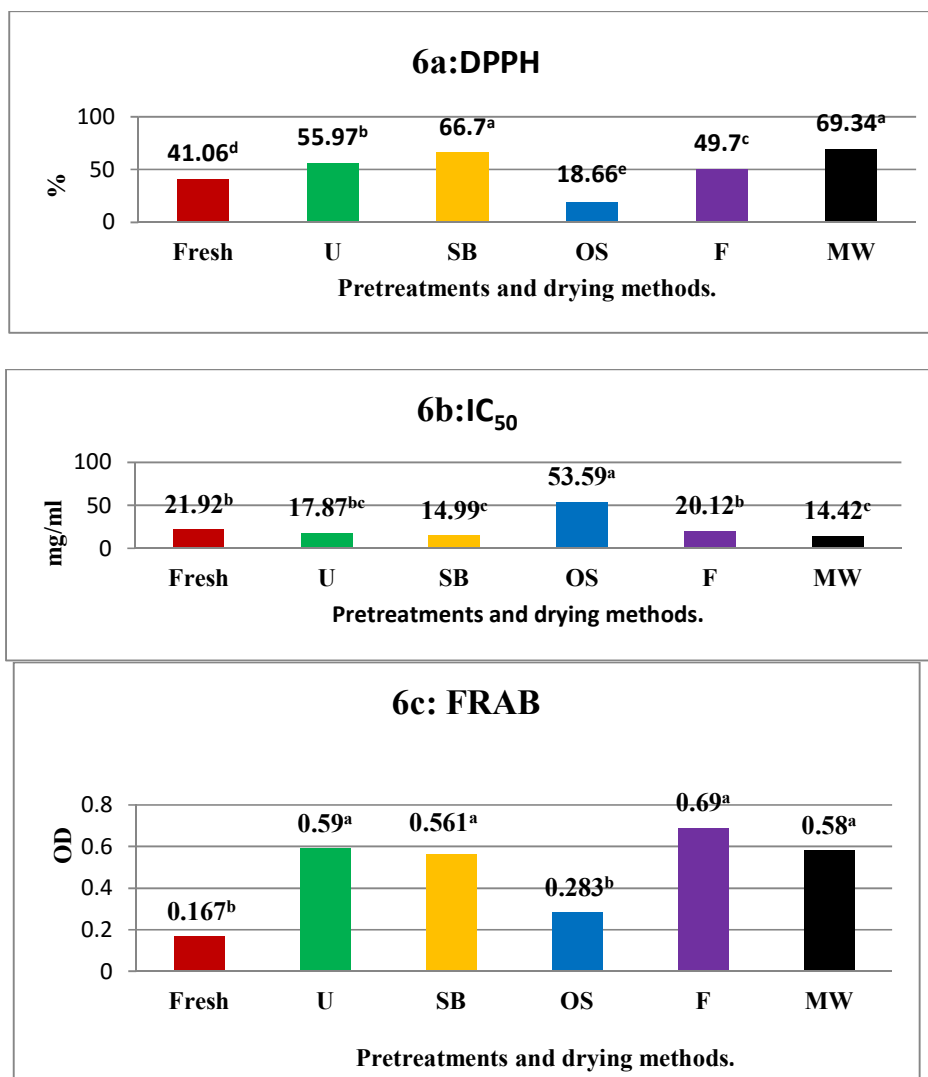

6a:DPPH

6b:IC_{50}

6c: FRAB

Fig. (6a,b,c). Antioxidant activity of pumpkin pulp as affected by

Pretreatments and various drying methods(on dry weight basis).

in the reduction in radical scavenging activity except OS (18.66% DPPH) that caused decrement. This may be due to the high content of sucrose gain during osmotic process. Their were relationship between polyphenol content and

scavenging activity against DPPH. MW and SB samples had the highest reduction scavenging activity and also the highest content of polyphenols, while OS had the lowest value of DPPH% and the polyphenol content. The correlation between polyphenol content and antioxidant activity of vegetables are reported in literature (Ismail *et al*., 2004 and Javaherashi *et al*., 2012). The bioactivity of phenolic compounds could be related to their antioxidant capacity, which attributes to their ability to chelate metals, inhibit lipoxygenase and scavenge free radicals (Noilia *et al*.,2011). Also, positive relationship was observed between flavonoids and carotenoids as β-caroten content of the samples in the present study and the scavenging activity against DPPH. Beninger and Hosfieled (2003) and Javaherashti *et al*. (2012) found a positive correlation between antioxidant activity and flavonoid compositions. The results recorded by Henriques *et al*. (2012) are not in accordance with the results obtained in the present study and showed that in terms of antioxidant activity and amount of phenolic compounds showed the differences between the fresh pumpkin and the other states of drying (convective air drying and freeze- drying) are practically negligible, which means that even though some of the chemical components of pumpkin have changed with drying at different conditions, the compounds of functional importance within it do not change or get lost.

Statistically, there were no significant differences between the DPPH% for SB and MW treatments, while, high significant differences were observed between them (SB and MW) and all the other treatments.

Fig. (6b) shows the antioxidant activity expressed as IC_{50} for fresh and pumpkin pulp powder. It can be noted that IC_{50} value of fresh pumpkin was 21.92 mg/ml. Pumpkin pulp powder dried by MW and SB method had the lowest IC_{50} values (14.42 and 14.99 mg/ml, respectively), while, samples dried by OS had the highest IC_{50} value (53.59 mg/ml) among all the other treatments. IC_{50} values of U and F samples were 17.87 and 20.12 mg/ml , respectively. It can be observed that among the pumpkin powder samples, the samples that had the lowest IC_{50} had the highest DPPH, polyphenols, flavonoids and carotenoids as β- carotene content. Statistical analysis indicated that there were no significant difference between IC_{50} of fresh, U and F treatments, also, between SB and MW. In contrast, high significant differences were observed between OS sample and all the other samples.

Ferric reducing antioxidant power (FRAP)
The results of the ferric reducing antioxidant power (FRAP) of the extract are presented as O.D in Fig.(6c). It can be noted that the reducing power of fresh pumpkin extract was 0.167 ,while, the other dried samples had reducing power varied from 0.283 in case of OS sample to 0.690 for F samples. From the statistical point of view, it can be noted that there were no significant differences between U, SB,F and MW samples. The same trend was noted between fresh pumpkin sample and the OS sample.

REFERENCES

Achilonu, M. C., Nwafor, I. C., Umesiobi, D. O. and Sedibe, M. M. (2017). Biochemical proximates of pumpkin (*Cucurbitaeae* spp.) and their beneficial effects on the general well-being of poultry species. Journal of Animal Physiology and Animal Nutrition, 102: 5–16.

Adhau G.W., Salvi V.M, Raut R.W.(2015). Development and quality evaluation of pumpkin *(cucurbita pepo)* preserve: a value added product. International Journal of Advanced Research, 3: 57-62.

Adubofuor, J., Amoah, I. and Agyekum, P. B. (2016). Physicochemical properties of pumpkin fruit pulp and sensory evaluation of pumpkin-pineapple juice blends. American Journal of Food Science and Technology, 4 (4): 89-96.

Aherne, S.A. and O'Brien,N. M. (2002). Dietary flavonols: chemistry, food content, and metabolism. Nutrition, 18: 75-81.

Ali, M. Z. (2015). Nutritional Properties and Compositional Quality of some Functional Foods Made from Pumpkin. Ph D.Thesis, Faculty of Specific Education, Department of Home Economics, Alexandria University, Egypt.

AOAC (2007). Association of Official Analytical Chemists. AOAC International.(18[th]ed). Gaitherburg: Maryland, USA.

Araya-Farias, M., Macaigne, O. and Ratti, C. (2014). On the development of osmotically dehydrated sea buckthorn fruits: pretreatments, osmotic dehydration, postdrying techniques, and nutritional quality. Drying Technology, 32(7): 813-819.

Astorg, P. (1997). Food carotenoids and cancer prevention: an overview of current research. Trends Food Sci. Technol., 8: 406-413.

Beninger, C.W. and Hosfield,G.L.(2003). Antioxidant activity extracts, condensed tannin fractions, and pure flavonoids from *Phaseolus vulgaris* L. seed coat color genotypes. Journal of Agricultural and Food Chemistry, 51: 7879-83.

Bhat, M. A. and Bhat, A. (2013). Study on physico-chemical characteristics of pumpkin blended cake. J Food Process Technol., 4(9): 262-265.

Biesiada, A., Nawirska, A., Kucharska, A. and Sokó£-£Êtowska, A.(2011). Chemical composition of pumpkin fruit depending on cultivar and storage. Ecological Chemistry And Engineering, 18(1):11-17.

Biesiada, A., Nawirska, A., Kucharska, A.Z. and Sokół-Łętowska, A.(2009). The effect of nitrogen fertilization methods on yield and chemical composition of pumpkin (*Cucurbita maxima*) fruits before and after storage. Veget. Crops Res. Bull., 70, 202-211.

Brand-Williams, W., Cuvelier, M. and Berset, C. (1995). Use of free radical method to evaluate antioxidant activity, LWT-Food Science and Technology, 28:25-30.

Caili, F. U., Huan, S. and Quanhong, L. I. (2006). A review on pharmacological activities and utilization technologies of pumpkin. Plant Foods for Human Nutrition, 61(2): 70-77.

Caniço, F., Ramalho, M., Lima, G. and Quedas, F. (2005). Estudo da evolução da textura e cor da *Curcubita* spp. na pós-colheita e ao longo do tempo. 7º Encontro da Química dos Alimentos, 2.

Cerniauskiene, J., Kulaitiene, J., Danilcenko, H., Jariene, E. And Jukneviciene, E. (2014). Pumpkin fruit flour as a source for food enrichment in dietary fiber. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 42(1):19-23.

Chottanom, P., Sriwhung, N. and Kloyarun, P. (2014). Effect of osmotic dehydration on antioxidant compounds and sensory acceptance of vegetable snacks. Khon Kaen Agr. J., 42(4) :239-247.

Chweya, J. A. and P. B. Eyzaguirre (1999). The Biodiversity of Traditional Leafy Vegetables. International Plant Genetic Resources Institute, Rome, Italy.

Cruz, R. M., Vieira, M. C. and Silva, C. L. (2008). Effect of heat and thermosonication treatments on watercress (*Nasturtium officinale*) vitamin C degradation kinetics. Innovative Food Science and Emerging Technologies, 9(4): 483-488.

De Pee, S. (1996). Food-based Approaches for Controlling Vitamin A Deficiency: Studies in Breast Feeding Women in Indonesia (ph D.Thesis). University of Wageningen, The Netherlands.

Dewanto, V., Wu, X., Adam, K. K. and Liu, R.H. (2000).Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. Journal of Agricultural and Food Chemistry, 50: 3010–3014.

Dhiman, A. K., Sharma, D. K. and Attri, S.(2009). Functional constituents and processing of pumpkin: A review. Journal of Food Science and Technology, 46(5): 411-417.

Dirim, S. N. and Çalıskan, G. (2012). Determination of the effect of freeze drying process on the production of pumpkin (*cucurbita moschata*) puree powder and the powder properties. GIDA., 37 (4): 203-210.

Divya, P., Puthusseri, B. and Neelwarne, B. (2012). Carotenoid content, its stability during drying and the antioxidant activity of commercial coriander (*Coriandrum sativum L.*) varieties. Food Research International, 45(1): 342–350.

Dixon R. P.N.L., (1995). Stress-induced phenylpropanoid metabolism. The Plant cell, 7:1085-1097.

Doymaz, I. (2007). The kinetics of forced convective air drying of pumpkin slices. Journal of Food Engineering, 79: 243-248.

Doymaz, I. (2010). Effect of citric acid and blanching pretreatments on drying and rehydration of Amasya red apples. Food and Bio-products Processing, 88(2-3): 124-132..

Fedha, M. S., Mwasaru, M. A., Njoroge, C. K., Ojijo, N. O., and Ouma, G. O. (2010). Effect of drying on selected proximate composition of fresh and processed fruits and seeds of two pumpkin species. Agriculture and biology journal of North America, 1(6): 1299-1302.

Fernández-García, E., Carvajal-Lérida, I., Jarén-Galán, M., Garrido-Fernández, J., Pérez-Gálvez, A., and Hornero-Méndez, D. (2012). Carotenoids bioavailability from foods: from plant pigments to efficient biological activities. Food Research International, 46(2): 438- 450.

Filho, L., Gonçalves, A. K. R., Mauro, M. A., and Frascareli, E. C. (2011). Moisture sorption isotherms of fresh and blanched pumpkin (*Cucurbita moschata*). Food Science and Technology, *31*(3):714-722.

Gliguem, H. and Birlouez-Aragon, I. (2005). Effects of sterilization, packaging, and storage on vitamin C degradation, protein denaturation, and glycation in fortified milks. Journal of Dairy Science, 88: 891-899.

Goering, K. H. and Van-Soest, J. P. (1970). Forage Fiber Analysis (Apparatus, reagents, procedures and some applications). USDA Agricultural Handbook No.37

Guine, R. P. F., Pinho, S. and Barroca, M. J. (2011). Study of the convective drying of pumpkin (*Cucurbita maxima*). Food and Bioproducts Processing, 89: 422-428.

Gulcin, I., **ELmastas, M. and Aboul-Enein, H. Y.(2012).** Antioxidant activity of clove oil- A powerful antioxidant source. Arabian Journal of Chemistry,5: 489-499.

Henriques, F., Guine, R. and Barroca, M. J.(2012). Chemical properties of pumpkin dried by different methods. Croatian Journal of Food Technology, Biotechnology and Nutrition, 7 (1-2), 98-105.

Ismail, A., Marjan, Z. M. and Foong, C. W. (2004). Total antioxidant activity and phenolic content in selected vegetables. Food Chemistry, 87: 581-586.

Ismail, O. and Kocabay, Ö. G. (2016). Evaluation of the drying methods and conditions with respect to drying kinetics, colour quality and specific energy consumption of thin layer pumpkins. Bulgarian Chemical Communications, 48(3): 480-491.

Jaeger de Carvalho, L. M. J., Smiderle, L. A. S., Carvalho, J. L. V., Cardoso, F. S. N. and Koblitz, M. J. B. (2014). Assessment of carotenoids in pumpkins after different home cooking conditions. Food Science and Technology, 34(2): 365-370.

Javaherashti, M., Ghasemnezhad, M., Lahiji, H. S. and Shiri, M. A. (2012). Comparison of nutritional value and antioxidant compounds of some winter pumpkin (*cucurbita sp*) species fruits in iran. Advances in Environmental Biology, 6(10): 2611-2616.

Kingsly, R. P., Goyal, R. K., Manikantan, M. R., and Ilyas, S. M. (2007). Effects of pretreatments and drying air temperature on drying behaviour of peach slice. International Journal of Food Science and Technology, 42(1): 65-69.

Kiruthiga,V. and Krishnaprabha,V. (2015). Development and analysis of nutrients, antioxidants in sweet potato and pumpkin powder incorporated value added products. International Journal of Advanced Research in Biological Sciences, 2(4): 65–71.

Kulaitienė, J., Jarienė, E., Danilčenko, H., Černiauskienė, J., Wawrzyniak, A., Hamulka, J. and Juknevičienė, E.(2014). Chemical composition of pumpkin (*Cucurbita maxima* D.) flesh flours used for food. Journal of Food, Agriculture and Environment,12 (3& 4) : 6 1 - 6 4 .

Lee, S. J. and Lim, S. L.(2011). Osmo-dehydration pretreatment for drying of pumpkin slice. International Food Research Journal, 18(4): 1223-1230.

Mahmoud, A. G. (2009). Chemical and Technological Study on Pumpkin. M.Sc. Thesis, Agriculture College, Department of Food Science and Technology, Omar Al- Mukhtar University, Libya.

Mala, **K. S. and Kurian**, A. **E. (2016).** Nutritional composition and antioxidant activity of pumpkin wastes**.** International journal of pharmaceutical, chemical and biological sciences, 6(3): 336-344.

Mala, K. S., Kurian, A. E. and Srinivasulu, K. (2016). Effect of pre-treatments on the proximate composition of pumpkin flour**.** International Journal of Innovative Studies in Sciences and Engineering Technology, 2(5):17-24.

Marek, G. Radzanowska, J. Danilcenko, H. Jariene, E. and Cerniauskiene, J. (2008). Quality of pumpkin cultivars in relation to sensory characteristics. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 36 (1): 73-79.

Marques, L.G., Prado, M.M. and Freire, J.T.(2011). Vitamin C content of freeze-dried tropical fruits. International Congress on Engineering and Food, Athens, Greece, Vol III, 2005-2006.

Maurya, S. and Singh, D. (2010). Quantitative analysis of total phenolic content in *Adhatoda vasica Nees* extracts. International Journal of Pharm Tech Research, 2:2403-2406.

Mahmoud, A. G. (2009). Chemical and Technological Study on Pumpkin. M.Sc. Thesis, Agriculture College, Department of Food Science and Technology, Omar Al-Mukhtar University, Libya.

Mohammed, A. A. (2004). Chemical composition and oil characteristics of pumpkin (*Cucurbita maxima*) seed kernels. Food Science and Agriculture, 2(1): 5-18.

Naser, M. A., Amin, W. A. and Siam, M. A. (2002). Quality and stability of some new pumpkin (*Cucurbita moschata*) edible products. J. Agric. Sci. Mansoura Univ., 27:5411-5420.

Nawirska, A., Sokól-Lętowska, A., Kucharska, A. Z., Biesiada, A. and Bednarek, M. (2008). Comparing the contents of dietary fiber fractions in some varieties of *Cucurbita maxima* and *Cucurbita pepo*. żywność: Nauka. Technologia. Jakość. 1(56):65-73 (in Polish).

Nawirska-Olszańska, A., Biesiada, A., Sokół-Łętowska, A. and Kucharska, A. Z.(2011). Content of bioactive compounds and antioxidant capacity of pumpkin puree enriched with Japanese quince, cornelian cherry, strawberry and apples. Acta Scientiarum Polonorum Technologia Alimentaria, 10(1): 51-60.

Niewczas, J., Mitek, M., Korzeniewska, A. and Niemirowicz-Szczytt, k. (2014). Characteristics of selected quality traits of novel cultivars of pumpkin (*Cucurbita Maxima* Duch.). Polish Journal of Food and Nutrition Sciences, 64 (2): 101–107.

Noelia, J., Roberto, M.M., de Jesus, Z. J. and Alberto, G. J.(2011). Chemical and physicochemical characterization of winter squash (*Cucurbita moschata* D). Notulae Botanicae Horti Agrobotanici Cluj, 39(1): 34-40.

Nowicka, P., Wojdyło, A., Lech, K., and Figiel, A. (2015). Influence of osmodehydration pretreatment and combined drying method on the bioactive potential of sour cherry fruits. Food and Bioprocess Technology, *8*(4): 824-836.

Olajire, A. A. and Azeez, L. (2011). Total antioxidant activity, phenolic, flavonoid and ascorbic acid contents of Nigerian vegetables. Africa Journal of Food Science and Technology, 2: 22-29.

Oyaizu, M. (1986). Studies on products of browning reactions: antioxidative activities of browning prepared from glucoseamine. Japanese Journal of Nutrition, 44: 307-315.

Oyekunle, O. J. and Abosede, O. T. (2012). Growth, yield and nutritional compositions of fluted pumpkin (*Telfairia Occidentalis*) as affected by fertilizer types in Ogbomoso, south west Nigeria. Bull. Environ. Pharmacol. Life sci.; 1 (9): 81 – 88.

Pandey, S., Singh, J., Upadhyay, A. K., Ram, D. and Rai, M. (2003). Ascorbate and carotenoid content in an Indian collection of pumpkin (*cucurbita moschata).* Cucurbit Genetics Cooperative Report, 26:51-53.

Pongjanta, J., Naulbunrang, A., Kawngdang, S., Manon, T. and Thepjaikat. T. (2006). Utilization of pumpkin powder in bakery products. Songklanakarin J. Sci. Technol., 28: 71-79.

Ranganna, S. (1977). Manual of Analysis of Fruit and Vegetable Products. 9thed. New Delhi: McGraw Hill p 112.

Robinson, R. W. and Decker-Walters, D.S.(1997). Cucurbits, CAB International, New York, NY.

Rodriguez-Amaya, D. B. and Kimura, M. (2004). HarvestPlus handbook for carotenoid analysis (HarvestPlus Technical Monograph 2). Washington: HarvestPlus.

Saboo, S. S., Thorat, P. K. and Khadabadi, S. S. and Khadabadi, S. S.(2003). Ancient and recent medical uses of *Cucurbitaceae* family. International Journal of Therapeutic Applications, 9:11-19.

Saha, B. C. (2003). Hemicellulose bioconversion. Journal of Industrial Microbiology and Biotechnology, 30(5): 279-291.

Samaha, O. R. (2002). Evaluation of pumpkin fruits a promising crop in food processing. Alexandria Journal of Agricultural Research, 47 (2): 117-125.

Sharma, S. and Rao, R. T. V.(2013). Nutritional quality characteristics of pumpkin fruit as revealed by its biochemical analysis. International Food Research Journal, 20(5): 2309-2316.

Shofian, N. M., Hamid, A.A., Osman, A., Saari, N., Anwar, F., Dek, M.S.P. and Hairuddin, M. R. (2011). Effect of freeze-drying on the antioxidant compounds and antioxidant activity of selected tropical fruits. International Journal of Molecular Sciences, 12(7):4678-4692.

Steel, R. B. D. and Torrie, T. H. (1980). Principles and Procedures of Statistics. USA: MS Graw Hill Co.

Tamilselvi, N. A. and Jansirani, P.(2017). Evaluation of pumpkin (*cucurbita moschata* l.) genotypes for earliness, yield and quality. International Journal of Current Microbiology and Applied Sciences, 6(3): 1554-1559.

Torreggiani, D. and Bertolo, G. (2004). Present and future in process control and optimization of osmotic dehydration: from unit operation to innovative combined process: an overview. Advances in Food and Nutrition Research, 48: 173-238.

Van Het Hof, K. H., West, C. E., Weatstrate, J. A. and Hautvast, J. G. A. J. (2000). Dietary factors that affect the bioavailability of carotenoids. Journal of Nutrition, 130(3): 503-506.

Van-Soest, P. J., Robertson, J. B. and Lewis, B. A. (1991). Symposium: Carbohydrate methodology, metabolism, and nutritional implications in dairy cattle. Journal of Dairy Science, 74(10):3583-3597.

Vega-Mercado, H., Góngora-Nieto, M. M. and Barbosa-Cánovas, G. V. (2001). Advances in dehydration of foods. Journal of Food Engineering, 49(4): 271-289.

Vikram, V. B., Ramesh, M. N. and Prapulla, S. G. (2005). Thermal degradation kinetics of nutrients in orange juice heated by electromagnetic and conventional methods. Journal of Food Engineering, 69: 31-40.

Wang, p., Liu, J., Zhao, Q. and Hao, L. (2002). Studies on nutrient composition and utilization of pumpkin fruit. Journal of Inner Mongola Institute of Agriculture and Animal Husbandry, 23 (3): 52-54.

Zdunić, G. M., Menković, N. R., Jadranin, M. B., Novaković, M. M., Šavikin, K. P. and Živković, J. C. (2016). Phenolic compounds and carotenoids in pumpkin fruit and related traditional products. Hemijska industrija, 70 (4): 429–433.

الملخص العربي

تأثير المعاملات الأولية وطرق التجفيف المختلفة على بعض المكونات الكيميائية والنشطة حيوياً للب ثمرة القرع العسلى

خالد محمد محمد عبد الرزاق[١] , وفاء على أمين[١] , محمد عبد الحميد زيتون[٢] ,

انتصار عبد المحسن الدفراوى[٢]

[١]قسم بحوث تصنيع الحاصلات البستانية– معهد بحوث تكنولوجيا الأغذية– مركز البحوث الزراعية–

مصر

[٢]قسم علوم الأغذية – كلية الزراعة – سابا باشا – جامعة الأسكندرية – مصر

تم اجراء هذه الدراسة لتقييم تاثير عملية السلق بالبخار وعدم السلق و التجفيف الأسموزى والمعاملة بالميكروييف كمعاملات أولية بالاضافة الى استخدام التجفيف الصناعى بالهواء الساخن والتجفيد كطرق تجفيف لإعداد لب القرع العسلى المجفف. تم تقدير التركيب الكيماوى التقريبى, السكريات الكلية ,المختزلة ,غير المختزلة , الألياف التغذوية, بعض المركبات النشطة حيوياً ومضادات الاكسدة فى لب القرع العسلى المجفف . أوضحت النتائج أن المحتوى الرطوبى للقرع العسلى المجفف يمكن ترتيبه تنازلياً كالآتى: المعاملة بالميكروييف, معاملة السلق بالبخار, عدم السلق , التجفيد وأخيراً التجفيف الاسموزى. وقد ادت عمليات التجفيف المذكورة الى إزالة ٨٦,٤٤ و٨٦,٨٣ و٨٨,٧٥ و٨٩,٢٢ و٩١,٤٧ % من محتوى الرطوبة الأولى مما أدى إلى محتوى رطوبة نهائى بلغ ١٢,٣٣ و١١,٩٧ و١٠,٢٣ و٩,٨ و٧,٧٥% على التوالى. يعتبر لب القرع العسلى مصدراً غنياً لبعض المركبات النشطة حيوياً . أوضحت النتائج أن محتوى الكاروتينات (كبيتا كاروتين) والبولى فينولات والفلافونيدات وحمض الأسكوربيك كان كالاتى:٢٤,٧٣ملجم/١٠٠جم وزن جاف , ١٢٠,٢٢ ملجم مكافئ حمض جاليك/١٠٠ جم وزن جاف , ٢٤,٧٣ ملجم مكافئ الريوتن/١٠٠جم وزن جاف , ١٨١,٢١ ملجم /١٠٠جم وزن جاف على التوالى. أدت المعاملات المذكورة إلى زيادة المحتوى من البيتاكاروتين والبولى فينول ما عدا التجفيف الأسموزى الذى تسبب فى انخفاض واضح . زاد المحتوى من الفلافونيد ليصل الى ٣٣,٠٧ ملجم مكافئ الريوتن/١٠٠جم عند استخدام السلق بالبخار فى حين أن جميع المعاملات الأخرى أدت الى انخفاضه كما انخفض حمض الأسكوربيك بشكل كبير فى جميع المعاملات. باستثناء التجفيف الاسموزى , فقد تباينت قيم الأصول الحرة (مضادات الاكسدة) بطريقة DPPH بين ٤٩,٧% فى حالة التجفيد الى ٦٩,٣٤% فى حالة الميكروييف وعلى الجانب الأخر تباينت قيم IC_{50} من ١٤,٤٢ الى ٥٣,٥٩ ملجم /مل.