EFFECT OF BLANCHING TREATMENTS AND FROZEN STORAGE ON THE QUALITY ATTRIBUTES OF FROZEN ARTICHOKE

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Abstract

The aim of this study is to make Artichoke available all the year around and to compare the effect of blanching methods on the physical and chemical properties of the artichoke under study. Artichoke (Cynara Scolymus) Balady cv. was brought from Qaha Experimental Farm, Qalyoubia Governorate, and blanched within 10 hours of harvest. It was blanched by three methods. Conventional, boiling in 0.3%citric acid solution for a period of 2,4 and 6 minutes, Steam under atmospheric pressure for 10, 15, and 20 minutes. Bracts were heated in microwave using non rigid thermoplastic bags filled with 60 ml 0.3% citric acid solution for 2,3 and 4 minutes. The blanched bracts were cooled down, drained, packed in polyethylene pouches under vacuum, sealed, labeled, frozen at -20ºC and stored in deep Freezer at -18ºC ±2 for six months .The effect of blanching treatment before and after being blanched on peroxidase activities, color ,firmness, ascorbic acid, dry matter, amino nitrogen and mineral contents including (Ca, P, Mn, Na, K, Fe, Zn, and Cu) were studied and discussed. This indicates better quality for Microwave blanched artichoke. Also, Changes in chemical composition of artichoke after being frozen and stored for six months were meagre . Also, changes in chemical composition as well as organoleptic properties of the frozen stored artichoke were evaluated after being cooked which indicates better quality for Microwave blanched artichoke that retained the greatest amount of ascorbic acid and had lighter appearance, good visual color, texture and flavor scores as revealed by the organoleptic panel test.

The study indicated that the overall quality of Microwave blanched Artichoke was as good as or superior to boiling water and steam blanched vegetables. Microwave blanching is a suitable alternative to boiling water or steam blanching when preparing vegetables for home freezing .

Key words: Artichokes, Peroxidase, Color, Firmness, Blanching, Frozen Storage.

INTRODUCTION

Artichoke is considered a healthy food due to its nutritional and photochemical composition since it contains proteins, minerals, a low amount of lipids, dietary fibers and high proportion of phenolic compounds, thus it is recommended to people of all age groups because it stimulates the liver function, helps to purify the blood and dissolves stones *(Fratianni et. al., 2007)* and *(L utz et. al., 2011).*

Consumer preferences are based primarily on external characteristics such as visual appearance and texture. An important component of visual appearance is color (*Gnanasekharan et. al.,1992*). Color can be stabilized by the blanching process (Klein, 1992).

With increasing awareness of nutritional quality and attention to dietary guidelines, consumers are interested in processed vegetables to maintain acceptable external quality characteristics that ensure nutrient retention (*Brewer et. al.,1994*).

Blanching is a unit operation prior to freezing, canning, or drying in modifying texture, preserving color, flavor, nutritional value, and removing trapped air. Hot water and steam are the most commonly used heating media for blanching in industry. Most vegetables are blanched prior to freezing to inactivate enzymes that cause the development of off flavors and off color during frozen storage.

Blanching of vegetables before processing reduces microbial load, improves color, aids in package fill, and assists in the development of a desirable texture. Blanching can leach large amounts of nutrients and solids that are never recovered (Drake and Carmichael, 1986). Blanching may result in some loss in texture, flavor, and nutritional quality due to the heating process, formation of a cooked taste, some loss of soluble solids, and adverse environmental impact because of the need for large amounts of water and energy (Klein 1992).

Also blanching was originally used to designate those heat treatment of food before being frozen, to prevent deteriorative changes that occur in food being not so heated *(Williams et. al., 1986)*, (Halpin and Lee, 1987).

Peroxidase, the most heat-stable enzyme in plants, is used as an indicator of blanching process adequacy (*Brewer et. al., 1994).* Peroxidase combines with a wide range of food constituents including ascorbic acid, carotenoids and fatty acids. Some of these reactions cause undesirable changes in food materials, including off-flavor , aroma, and color, as well as the loss of some nutrients (Hemeda and Klein, 1990).

In vegetables, ascorbic acid is one of the most heat labile nutrients, it is water soluble, pH, light –and heat sensitive and readily oxidizable by the naturally occurring enzyme system, ascorbic acid oxidase (*Brewer et. al.,1994).* The loss of soluble nutrients during blanching are not due to oxidation but mostly ascribed to their solubilities.(Fennema,1977) mentioned that the loss of ascorbic acid during boiling water blanching of peas was due primarily to leaching effect. Most vegetables showed a reduction of firmness with increasing temperature over 45°C (Bourne 1982).

Steam blanching is more energy-efficient and produces lower biological oxygen demand (BOD) and hydraulic loads than water blanching. In addition, nutrient leaching is reduced compared to water blanching *(Jose et. al., 2004).* Blanching facilitates peeling and dicing, are also accompanied by microbial load reduction (Rahman and Perera , 1999). Different hot water and steam blanchers have been designed to improve product quality, increase yield, and facilitate processing of products with different thermal properties and geometries.

More recently, energy conservation and waste reduction studies on microwave vegetable blanching date back to the 1940s (Lee, 1958). Among the first important finding were retention of ascorbic acid and carotene, and very short processing time compared to conventional water or steam blanching Microwave technology has been combined with water blanching to further reduce heating time (*Devece et al.,1999*) and(*Ramesh et. al.,2002)*. Microwave blanching could improve product quality and minimize waste production (*(Jose et. al., 2004)* .

Finally, it remains to be shown that the shorter processing times of microwave ovens will result in reducing operating costs and higher value products, thereby compensating for equipment cost.

The objective of this study was to compare the effect of blanching methods on the physical as well as the chemical properties of the Artichoke under study such as ascorbic acid, minerals, moisture contents, peroxidase activities, color, firmness and sensory characteristics of artichokes. Beside changes that might occur due to frozen storage were determined including moisture, protein, lipid, sugars crude fiber, ash, ascorbic acid, total titratable acidity and pH value .

Accordingly, the present research was carried out :

1- To study the physical and chemical properties of raw artichoke after being blanched by different methods .
2- To study changes that could occur in frozen artichoke after being stored for six month at -20±2ºC.

MATERIALS AND METHODS

Artichoke (Cynara scolymus) balady variety was brought from Qaha Experimental farm Qalyoubia Governorate. Uniform green color compact globes and tightly adhering leaves were selected. All leaves choke or fussy portion and the stem below the heart were cut away and trimmed of any woody portion and kept under 0.3%citric acid solution. Thereafter, these hearts were blanched using different methods:

1- Blanched using 0.3%citric acid solution at (100ºC)for a period of (2-4 and 6 minutes).

2- Using microwave oven for 2,3 and 4 minutes with a power rating of 650 watts. The artichokes were placed in non rigid thermo plastic bag with 60ml 0.3%citric acid and suspended in the microwave oven.

3- Using steam (under atmospheric condition) for 10 -15 and 20 minutes.

All the blanched hearts were cooled down using an ice water quench to stop the process. The blanched artichokes were drained thoroughly after cooling , packed in polyethylene pouches, sealed under vacuum , frozen at -20ºC and stored at -18ºC±2 for six months. Different samples of frozen artichoke were drawn every three months to test for color firmness and nutritional values. Beside, organoleptic panel test was carried out by a well trained panelists who gave scores for firmness flavor, color and overall acceptability using artichoke hearts after being cooked.

Methods

The Artichoke hearts were analyzed after being blanched for firmness using (Mecmesin Forces and Torque) advanged Force Gauge FG 250N. Color determinations were carried out using (Minolta color meter chroma meter CR400). Color measurements were carried out in 2 different position of the artichoke hearts of which the first was the inner portion while the second was the outer surface. Ten replicates were measured for every treatment. Minolta which defines the color in 3 dimensional spaces *L to indicate lightness and a*, b* are the chromaticity coordinates. Color difference between the fresh and processed artichokes were available using the following equation.

$$E^{\frac{1}{2}} = \sqrt{\left[(\Delta l)^2 + (\Delta a)^2 + (\Delta b)^2\right]}$$

Moisture content (vacuum oven method), total titratable acidity, pH values, reducing and total reducing sugars, free amino nitrogen, ash, crude fiber, protein, lipid, were determined according to the methods described in the (AOAC 1990), while minerals were determined after being ashed and acid solubilised by atomic absorption spectrophotometer. Phosphorus (P)was determined according to (Trouge and Mayer 1962).

Sensory evaluation with a trained panel

Panelists relied on their training experience to score products after being cooked for ,color, firmness, flavor and the overall acceptability for degree of liking (1=dislike extremely, 10 =like extremely).

Statistical analysis

All data were subjected to analysis of variance (ANOVA) treating blanching treatment as the main effect. Means that were significantly different ($p < 0.05$) were separated using Fisher´s least significant difference (LSD) test. Sensory date were subjected to a one-way ANOVA for repeated measures and means were separated using LSD.

Peroxidase activities

Peroxidase activity was determined spectrophotometrically as described by (Hemeda and Klein, 1990).Vegetable (20g) was homogenized (1 min) with cold deionized water (50ml), made up to 100 ml and filtered (whatman #42). Substrate (2.9 ml of 0.3% H_2O_2, 1% guaiacol in 0.5 M sodium phosphate buffer, pH value (6.5) and vegetable filtrate (0.1 ml) were combined in a cuvette. Absorbance (470nm) was red at 1- min interval for 2min. Enzyme activity is expressed as change in absorbance /min, 1 unit of activity is defined as a change in absorbance of 0.001/ min.

Reduced ascorbic acid

Reduced ascorbic acid (RAA) was determined using the titrimetric assay described by (Pelletier,1985).Ground artichoke (25g) was extracted with 100 ml 6% metaphospheric acid for 2 min using a blender made up to 250 ml with 6% metaphospheric acid and filtered by (whatman# 2)Duplicate aliquots((10m) of filtrate were titrated with 2,6-dichlorophenolindophenol.

True retention was calculated as percent of total RAA in raw unblanched sample retained in the cooked sample.

RESULTS AND DISCUSSION

Enzyme inactivation

Blanching is considered a very important unit process to inactivate different oxidizing enzymes such as peroxidase, catalase, lipoxigenase and polyphenol oxidase. These enzymes cause detrimental effect on color and also change the flavor during the frozen storage .

Accordingly, their activities must be minimized to avoid their effect on quality since peroxidases are the most resistant enzymes to thermal treatment. They always have been taken as an indicator enzymes as their inactivation proved the killing of other enzymes. Results in Table (1) indicate that enzyme activities reached zero when treated in boiling citric acid 0.3 % for six min or using microwave oven for 4 min. When the artichoke samples were covered with 60ml 0.3 % citric acid in non rigid thermoplastic bags and suspended in the microwave oven .

However, the blanching period was extended to 20 min when using steam at atmospheric pressure to obtain peroxidases zero activities. This long period of thermal treatment would affect different quality attributes of artichoke hearts including color firmness and flavor. It seems that the best method which could be applied in this respect is the microwave oven. To perform a good blanching it is important to inactivate all POD forms to avoid oxidation in frozen artichoke. There is a threshold of temperature (80ºC**)** below which the process of heat inactivation of POD does not occur efficiently. At 100ºC the blanching time is a very critical factor in the same time avoiding the over blanching is very important since it could impair color, consistency and loss of valuable components e.g. vitamins, proteins, amino acid and flavor.

Table 1. Effect of blanching treatments on peroxidases activity .

Treatments	Enzyme activities OD 470 mu / min	Activities%
Fresh	0.246	100%
Blanching in boiling 0.3%citric acid solution for:		
2min.	0. 062	25.20
4min.	0.008	3.25
6min.	0.000	0.00
Steam at atmospheric pressure for:		
10min.	0. 086	34.96
15min.	0.009	3.66
20min.	0.000	0.00
Microwave oven : 0.3% citric acid for:		
2min.	0.058	23.57
3min.	0.007	2.85
4min.	0.000	0.00

Discoloration of artichoke hearts as a result of enzymatic or chemical reactions or both could affect drastically the consumer preference. Some slight peroxidase regeneration occurred in blanched samples while it decreased in the unblanched samples during freezing storage. These results agree with those of (Wang and DiMarco 1972) who mentioned that during high temperature short- time (HTST) treatments of vegetables regeneration occurs within hours or days of heat treatment and may even occur after several months of freezer storage. Results in Table (2) represent the values of Minolta ChromameterCR-400 difference meter L a b.
These values were calculated as E ½Δ: color difference:

$$E\overset{1}{\Delta} = \sqrt{\left[(\Delta l)^2 + (\Delta a)^2 + (\Delta b)^2\right]}$$

Using the color values of fresh artichoke hearts as a reference. Discoloration reaction could be due to enzymatic reaction which induced a pink color on the inner surface of the artichoke heart or due to Maillard reaction which darken the color allover the artichoke heart. The later could be slightly carried out during the frozen storage period. Results in Table (2) reveal that a slight differences in color could be observed between the color of artichoke hearts blanched in boiling solution of 0.3% citric acid and with microwave oven where the artichoke were placed in thermoplastic bags and suspended in the microwave oven for 4 min. On contrary, there were obvious difference in color when using the steam (under atmospheric pressure) for the blanching process. It seems that Microwave treatment could keep color within minimum discoloration when compared to the color of fresh artichoke.

Table 2. Color measurements of globe artichoke as affected by blanching methods.

Treatments	L	a	b	$\triangle E^{\frac{1}{2}} = \sqrt{\left[(\Delta l)^2 + (\Delta a)^2 + (\Delta b)^2\right]}$
Fresh: artichoke	**73.75**	**-4.6**	**22.26**	**-----**
Boiling for 0.3% citric acid for 6 min	**67.6**	**-3.1**	**21.31**	**6.45**
Steam at atmospheric pressure for 20 min	**61.17**	**-2.81**	**21.3**	**12.69**
Microwave oven for 4 min*	**68.36**	**-3.5**	**20.13**	**5.88**

* where the artichokes were placed in rigid thermoplastic bags suspended in the microwave oven.

Firmness is another factor which influnced the organolepic parameter. Results in Table (3) reveal that the fresh artichoke hearts had the highest value (139) followed by microwave oven (40.20), 0.3% boiling solution of citric acid (28.31) and steam at atmospheric pressure (11.13).

Accordingly to the best method which could be used for blanching was the use of microwave oven.

Table 3. Firmness measurement of globe Artichoke as affected by blanching methods.

Treatments	Firmness unit gm/ cm2	Decrement%
Fresh : artichoke	139.0	-------
Boiling water	28.31	79.60
Steam at atmospheric pressure	11.13	91.90
Microwave oven *	40.20	71.07

* Where the artichokes were placed in rigid thermoplastic bags suspended in the microwave oven .

Results in Table (4) reveal that blanching process had an obvious effect on ascorbic acid since it decreased from 12 mg /100g to 10.3,6.8 and 8.8mg for the fresh and those blanched in boiling 0.3 % citric acid (6min) respectively. These decrements could be referred to both leaching and /or oxidizing processes. The same action was happened to both dry matter and amino nitrogen since they decreased slightly due to blanching process.

Table 4. Effect of blanching treatments on ascorbic acid, dry matter and amino nitrogen.

Treatments	Ascorbic acid (mg/ 100g)	Dry matter%	Amino nitrogen (mg/100g)
Fresh : artichoke	12	16.4	20
Boiling : 0.3% citric acid for 6 min	6.8	15.1	16
Steam at atmospheric pressure: 20 min	8.8	16.1	18
Microwave oven: 4 min*	10.3	15.8	19

* Where the artichokes were placed in rigid thermoplastic bags suspended in the microwave oven .

Results in Table (5) reveal that blanching treatment using both thermal treatment and 0.3 % citric acid solubilised the mineral contents of artichoke at different rates according to their solubilities. High losses were obtained for Na, and K followed by Ca, P, and Mg however the losses of Mn, Zn, Cu and Fe were meagre .

Table 5. Effect of blanching treatments on mineral contents of artichoke (mg/100g).

Treatments	Ca	P	Mn	Mg	Na	K	Fe	Zn	Cu
Fresh : artichoke	46	88	61	27	96	398	1.39	0.50	0.29
Boiling for 0.3% citric acid for 6 min.	39	71	54	21	61	204	1.10	0.41	0.21
Steam at atmospheric pressure for 20 min.	44	74	57	26	86	293	1.23	0.43	0.28
Microwave oven for 4 min.	41	82	54	23	87	351	1.22	0.46	0.22

* Where the artichokes were placed in rigid thermoplastic bags suspended in the microwave oven .

Changes in chemical composition due to frozen storage being studied in frozen artichoke blanched by the microwave methods since it was the best method of blanching. Chemical composition of artichoke hearts had mild changes in both sugars and ascorbic acid. Results in Table (6) represent changes in different components during frozen storage, On contrary a meagre increase in sugar percent could be observed due to moisture condensed on the inner surface of the pouch and which could be the reason for decreasing moisture percent. However the decreasing in ascorbic acid could be due to both the oxidases enzymes while the increasing in total and reducing sugar could be referred to the conversion of both sucrose and inuline to fructose. However enzymatic reaction could proceed in a very slow manner because of the low storage temperature of the frozen artichoke (-20 ±2) To ensure high quality of frozen vegetables, temperature should be controlled and not fluctuated during frozen storage.

Table 6. Changes in chemical composition of artichoke during frozen storage.

Period of frozen storage in months	Moisture %	Protein %	Lipid %	Sugars %			Crude fiber %	Ash %	Ascorbic acid mg/100gm	Titratable acidity citric acid gm/100gm	pH
				R*	NR*	T*					
Fresh	83.71	3.81	0.18	0.66	0.39	1.05	5.32	1.23	12.0	0.172	5.2
Directly after blanching	83.99	3.51	0.18	0.61	0.37	0.98	5.31	1.23	10.3	0.163	5.2
3 months after frozen storage	82.6	3.95	0.18	0.62	0.36	0.98	5.30	1.23	8.9	0.159	5.2
6 months after frozen storage	82.15	3.90	0.19	0.69	0.87	1.56	5.31	1.23	5.1	0.152	5.2

For Artichoke blanched by Microwave Method.
*R: Reducing sugars.
*NR: Non reducing sugars
*T : Total sugars.

Organoleptic properties is of utmost importance since it directly affect the consumer acceptance. Results in Table (7) reveal that color was almost as that of fresh artichoke, after being blanched whereas flavor and texture decreased moderately as indicated by given scores. Meanwhile the overall acceptability slightly decreased.

Conclusively the organoleptic scores in general were almost always as that of the first beginning of the frozen storage. It could be concluded that the best method for artichoke preservation was the blanching processing using microwave oven followed by the freezing process and frozen storage under controlled temperature (-20 ºC).

Table 7. Organoleptic evaluation of cooked Artichoke after being frozen storage(-20±2) .

Period of storage in months	Color	Flavor	Texture	Overall acceptability
After blanching	9.6	7.6	9.6	9.7
3 months	9.0	6.0	8.8	7.2
6 months	8.6	6.8	7.6	7.3
L.S.D: 0.5	0.12	0.17	0.23	0.32

For Artichoke blanched by Microwave Method.

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تاثير معاملات السلق والتخزين المجمد علي صفات الجودة للخرشوف المجمد

جميلة يوسف عطية

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تهدف هذه الدراسة الي توفير الخرشوف علي مدار العام ومقارنة تاثير طرق السلق المختلفة علي الصفات الطبيعية والكيماوية للخرشوف تحت الدراسة حيث تم الحصول علي الخرشوف الصنف البلدي من مزرعة تجارب قها (القليوبية) وتم معاملاتها بالسلق في خلال 10 ساعات من الحصاد وقد اجريت عمليات السلق بثلاثة طرق :

1- الطريقة العادية : السلق في حامض ستريك0.3 % لمدة 2-4-6 دقائق.

2- السلق بالبخار تحت الضغط الجوي العادية : لمدة 10- 15 -20 دقائق.

3- استعمال الميكروويف الموجات المتناهية القصر : وذلك بوضع الخرشوف في اكياس بلاستيكية حرارية غير صلبة مع 60 مل 0.3%حامض ستريك لمدة 2-3-4 دقيقة. ثم تم التبريد بالماء الجاري والتصفية من الماء الزائد والتعبئة في اكياس من البولي ايثيلين تحت تفريغ والتغليف والتجميد علي – 20 مْ والتخزين بالتجميد علي –18 مْ لمدة ستة اشهر .حيث تم دراسة ومناقشة تاثير طرق السلق السابق ذكرها قبل وبعد السلق علي اللون والصلابة و نشاط انزيم البيروكسيديزوحامض الاسكوربيك والنتروجين الاميني والمعادن وشملت الكالسيوم والفسفور والمنجيز والصوديوم والبوتاسيوم والحديد والزنك والنحاس. وتشير احسن صفات الجودة ان الخرشوف المعامل بالميكروويف الموجات المتناهية القصركان افضل المعاملات. وخلال فترة التخزين تم دراسة التغيرات الخاصة بالتركيب الكيماوي للخرشوف المجمد و المخزن لمدة ستة اشهر تحت–18 مْ حيث كانت بسيطة.

ايضا تم دراسة التغييرات في الصفات الحسية للخرشوف المجمد والمخزن بعد طبخه وقد اظهرت الدراسة ان الخرشوف المعامل بالميكروويف الموجات المتناهية القصركان افضل في صفات الجودة حيث احتفظ بكمية كبيرة من حامض الاسكوربيك وكان ذو مظهر جيد من حيث اللون والقوام والطعم حيث اعطيت درجات عالية بواسطة الاختبارات الحسية.

اثبتت هذه الدراسة ان السلق باستعمال الميكروويف الموجات المتناهية القصر افضل من السلق في الماءاو السلق بالبخار للخضروات لذلك السلق بالميكروويف الموجات المتناهية القصر يعتبربديل مناسب للسلق بالماء او السلق بالبخار عند تجميد الخضروات منزليا.