Horticultural and Technological Evaluation of New Five Genotypes of Okra [*Abelmoschus Esculentus* (L.) Moench].

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ABSTRACT

This study was carried out during the three successive seasons of 2005, 2006, and 2007 at Sabahia Horticultural Research Station, Alexandria, Egypt. Plant materials of this study consisted of five genotypes of okra. Their chemical characteristics, physicochemical, and organoleptic properties were evaluated. Likewise, the effects of freezing process and storage conditions on the characteristics of these genotypes were investigated. It was found that "Alexandria 2" variety gave the highest mean values for edible weight, diameter, and dry weight of the pod. Meanwhile, "Alexandria 1" variety and "line 1" had the longest pod, but the "line 2" had the shortest one. Whereas, the thinnest pod was obtained by "line 1". Also, "line 1" gave the highest yield of edible pod. The differences evaluated between the tested genotypes proved significant concerning all characters at the most studied locations. There were significant differences in chemical composition of the tested five genotypes. However, the results showed no significant difference between the mucilage content of the tested genotypes. The other physicochemical parameters ; via, ascorbic acid, chlorophyll a, b and total chlorophyll had somewhat significant differences. The pretreatment of freezing process (blanching in water) was the cause of increasing the protein and decreasing ash, carbohydrates and ether extract. On the other side, freezing procedure had no significant effect on crude fiber content. The storage period (9 months) at temp. of – 20 °C, exhibited no significant effect on the chemical composition of okra pods. There were noticeable decrease (or loss) in the ascorbic acid and chlorophyll a, b contents during the storage. On the other hand, insignificant effect was noticed in mucilage during storage period. However, the panelists accepted all the samples of cooked okra pods either fresh or after 9 months of frozen storage.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a member of the *malvacea* family. Originally- an Indian plant- is one of the most popular and widely grown vegetable crops (Woolfe *et al.*, 1977). It is, largely, grown in all regions of the world with a tropical or Mediterranean climate for its immature pods. It grows, normally, in hot weather (temperatures above 26°C). Nowadays, the most important okra-producing countries are India, Nigeria, Pakistan, Ghana, and Egypt (FAO, 2003). It can be consumed as a fresh or a cooked vegetable, as a thickening agent for soups or as an addition for salads and stews. On the other hand, the pods can be used

directly as fresh or preserved i.e., chilled, frozen, dried and canned, for later use. Okra provides some amount of vitamins, dietary fiber, energy and minerals (Adom *et al.*, 1997). Fresh okra pods have a short post harvest life, being prone to physical and physiological changes that reduce quality (Singh *et al.*, 1978). It should be in the market within few hours of harvest and shipped under refrigeration.

This investigation aimed to evaluate five genotypes of okra for their chemical characteristics, physicochemical, and organoleptic properties. The effect of freezing process and storage conditions on the characteristics of these genotypes were investigated also.

MATERIALS AND METHODS

1. Horticultural evaluation

The present study was carried out during the three successive seasons of 2005, 2006, and 2007 at Sabahia Horticultural Research Station, Alexandria, Egypt. Plant materials of this study consisted of five genotypes of okra. These genotypes were two varieties and three breeding lines of okra. The varieties were "Alexandria 1" and "Alexandria 2", whereas, the lines were originated from a breeding program, started in the summer season of 1995 at the above-mentioned Research Station, Alexandria, Egypt (Abd-Allah and Mansour, 2005).

A randomized complete block design was used. Seeds of okra were planted in a single row, 4m long, 0.7 m wide and hills 30 cm apart at the rate of 4 seeds per hill. Each plot contained 5 rows. The plot area was 14 m^2 for each. Sowing date was on the first of May. Three weeks later, seedlings were thinned and the strongest one being remained in each hill. Other cultural practices were carried out as recommended for the conventional okra planting. Harvesting took place during the period from mid of June up to mid of September. Pods were picked with all pedicels in the morning every 3 days interval. The following traits were recorded, as an average data of 50 edible pods per plot; pod length and diameter (cm), weight (g). Pod dry matter (%) was measured as the average of three different pickings and expressed as dry weight / fresh weight x 100. Total edible yield (Kg/fed) was calculated based on the plot area.

In 2006, consumers' evaluation of the fresh okra pods was done at five locations by a random sample of twenty consumers to detect the best entry from their viewpoint. These locations were Alexandria, Cairo, Minia, Beny Suif, and Mansoura governorates. Color, spiny character,

appearance, and general acceptance were scored from 1 to 5, which 1 is poor and 5 is excellent.

The obtained data were statistically analyzed and tabulated. Simple correlation coefficients (r) were calculated for different pairs of the studied characters according to Dospekhov (1984) and the differences were detected by the revised L.S.D at 0.05 level of probability.

2. Technological methods:-

2.1. Freezing process:

Five kilograms of each genotype of okra pods were used for processing. Technological processing includes pre-freezing treatments, such as sorting, washing, trimming, and blanching at 90°C for 2 min. and cooling, followed by vacuum packaging in polyethylene bags (half kg in each bag). Samples were, quickly, frozen in an air blast freezer type foster at -25°C. Samples were stored in a deep freezer at -20°C for 9 months.

2.2. Cooking of fresh and frozen okra pods:

One kilogram of each genotype of fresh and frozen okra pods (at the end of storage period) , was used for cooking. Table (1) shows the recipe used for preparing cooked okra pods. Okra pods were cooked according to the methods described by Abo El-Anen (1982).

Table 1: Recipe of cooked okra pods.

Ingredient	Quantity (gm)	%
Okra pods	500	31.71
Tomato fruit	500	31.71
Onion	75	4.76
Garlic	15	0.95
Black pepper	2	0.13
Salt	10	0.62
Fat	75	4.76
Water	400	25.36

2.2.1. Analytical methods: One kilogram of fresh and frozen storage pods (each 3 months of storage period) was used for analysis. The proximate analysis of okra pods including, moisture, crude ether extract, crude protein (N X 6.25), crude fiber, and total ash were carried out according to the A.O.A.C. (1995) procedures unless otherwise stated. However, ascorbic acid was determined using 2,6-dichlorophenol indophenol dye as described by Ranganna (1977). Mucilage was estimated according to Woolf *et al.* (1977) method. Chlorophyll a, b and total were

determined using N,N-dimethylformamide as mentioned by Moran and Porath (1980).

2.2.2. sensory evaluation :- Appearance, colour, odour, texture, hardness, taste, and overall acceptability of the five genotypes of cooked fresh okra fruits and after 9 months frozen storage were assessed by the panelists of Food Technol. Laboratory, Food Technol. Res. Inst., A.R.C., Sabahia, Alex., using hedonic scale as proposed by Ranganna (1977).

2.3. Statistical analysis:- Standard deviation as well as analysis of variance were calculated according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Horticultural evaluation:

1.1. Mean performance of the edible okra pods

Results of Table (2) show that "Alexandria 2" variety gave the highest mean values for edible pod weight, diameter and dry weight of pod. However, the mean values of "Alexandria 2" variety were similar, more or less, to "line 2" concerning edible pod diameter, also "Alexandria 1" variety and "line 3" with regard to dry weight of pod. Meanwhile, "Alexandria 1" variety and "line 1" had the longest pod, but the "line 2" had the shortest pod. Whereas, the thinnest pod was obtained by "line1". Furthermore, "line 1" gave the highest yield of edible pod. It was noticeable that pod color was dark green in "Alexandria 1" variety and "line 3", medium green in "Alexandria 2" variety and "line 2", and light green in "line 1". In this regard, Abd-Allah and Mansour (2005) established new lines of okra to improve and meet the need of new cultivars of okra for fresh consumption. They selected five lines i.e., "line 3" had tall, thin, and mild-green pods; "line 5" had short, thick, and relatively dark-green pods; "line 6" had tall, thin, and dark-green pods; "line 10" had mild-tall, thick, and relatively dark-green pods, and "line 12" had short, thick, and dark-green pods. On another study, six lines of okra were originated from a breeding program (Wahba, 2005). She reported that "line 3" had thin and tall pods. Meanwhile, "line 2" had thick pods and "line 6" had the shortest pods. Line 4 had dark green pods, while "line 3" had light green pods.

Table 2: Mean performance of the five okra genotypes with regard to some studied characters as mean of the three seasons, 2005, 2006, and 2007.

Genotypes	Edible pod weight (g)	Edible pod length (cm)	Edible pod diameter (cm)	Dry weight of pod (%)	Total pod yield (Kg/fed)	Pod colour
Alexandria 1	4.4	4.4	1.7	16.7	4805.8	Dark green
Alexandria 2	5.3	3.9	1.9	16.8	5005.8	Medium green
Line 1	4.0	4.4	1.3	15.2	5834.5	Light green
Line 2	3.9	3.3	1.8	15.0	4409.7	Medium green
Line 3	3.6	3.8	1.6	16.3	5497.8	Dark green
LSD (0.05)	0.22	0.13	0.13	0.68	69.73	

1.2. Consumers' evaluation of the edible okra pods

Evaluation the differences between the tested genotypes declared insignificant effects concerning pod color for Alexandria consumers (Table 3), but "Alexandria 1" and "Alexandria 2" varieties were preferred by Cairo, Minia, and Beny Suif consumers. In addition, Minia, and Beny Suif consumers preferred "line 2". Whereas, Mansoura consumers preferred "line 3".

Regarding pod spines (Table 3), Alexandria consumers preferred "Alexandria 1" variety and "lines 2 and 3". Cairo consumers preferred "Alexandria 1" and 2 and line 2. Minia consumers preferred "Alexandria 2" variety and "line 2". Beny Suif consumers preferred "line 1". Mansoura consumers preferred all the tested okra genotypes except of "line 3".

Table 3: Consumer's evaluation for some pod characters of the studied five okra genotypes at five locations in 2006.

Characters and Locations	Genotypes					LSD (0.05)
	Alex. 1	Alex. 2	Line 1	Line 2	Line 3	
Color						
Alexandria	3.6	3.8	3.1	3.6	3.7	n.s.
Cairo	4.6	4.6	3.7	3.9	3.5	0.19
Minia	4.1	3.9	3.5	3.9	3.2	0.26
Beny Suif	4.6	4.6	3.7	3.9	3.5	0.25
Mansoura	3.5	3.6	3.1	3.6	3.9	0.27
Spines						
Alexandria	4.7	4.5	4.5	4.6	4.7	0.15
Cairo	4.7	4.8	4.6	4.7	4.5	0.12
Minia	4.4	4.7	4.4	4.6	4.4	0.14
Beny Suif	4.4	4.3	4.7	4.3	4.0	0.22
Mansoura	4.1	4.0	4.1	4.0	3.8	0.15
Appearance						
Alexandria	3.7	4.0	4.1	3.6	3.7	0.21
Cairo	4.2	4.4	3.9	4.1	3.6	0.16
Minia	3.9	3.7	3.6	3.7	3.3	0.15
Beny Suif	4.1	3.8	4.1	3.8	3.4	0.18
Mansoura	3.7	3.8	3.7	3.6	3.7	n.s
General acceptance						
Alexandria	3.7	3.6	4.1	3.4	3.6	0.23
Cairo	4.4	4.4	4.2	4.3	3.7	0.19
Minia	3.9	4.1	4.0	4.1	3.4	0.20
Beny Suif	4.3	4.0	4.3	4.1	3.6	0.22
Mansoura	3.8	3.6	3.6	3.6	3.6	n.s.

n.s.= not significant

Appearance of "Alexandria 1" variety was preferred by Minia and Beny Suif consumers. Meanwhile, "Alexandria 2" variety was preferred by Alexandria and Cairo consumers. Whereas, "line 1" was preferred by Alexandria and Beny Suif consumers.

Concerning general acceptance (Table 3), Alexandria consumers preferred line 1, but Cairo consumers preferred "Alexandria 1 and 2" variety and "line 2". Minia consumers preferred "Alexandria 2" variety and "lines 1 and 2". Beny Suif consumers preferred "Alexandria 1" variety and "lines 1 and 2"

1.3. Correlation coefficient analysis:

Results of Table (4) illustrate the correlation values among pairs of pod characters and consumers evaluation for some pod characters. However, edible pod weight showed a positive correlation with consumers' evaluation for color and appearance. In addition, edible pod diameter exhibited a negative correlation with yield but positive correlation with consumers' evaluation pods color. Likewise, there were highly positive correlation between consumers' evaluation for spines and both of appearance and general acceptance. On the other extreme, consumers' evaluation for appearance positively correlated with general acceptance. These results indicated that consumers' evaluation for spines, appearance, and general acceptance were correlated with themselves. In addition, consumers' evaluation for color and appearance throughout fresh weight and diameter of edible pods, could be expected. These findings may be referred to spines and appearance of edible okra pods affect general acceptance for consumers

Table 4: Correlation coefficient values (r) for pair of characters of the studied five okra genotypes.

Characters	Edible pod weight	Edible pod length	Edible pod diameter	Dry weight of pod	Total pod yield	Color	Spines	Appearance
pod length	0.188							
pod diameter	0.558	-0.560						
Dry weight	0.584	0.333	0.449					
Total pod yield	-0.231	0.569	-0.808*	-0.031				
Color	0.767*	-0.019	0.827*	0.669	-0.687			
Spines	0.589	0.289	0.110	-0.128	-0.314	0.430		
Appearance	0.755*	0.484	0.129	0.168	-0.177	0.541	0.945**	
General acceptance	0.476	0.476	-0.098	-0.146	-0.151	0.305	0.971**	0.933**

*,** Significant differences at 5% and 1% levels of probability, respectively.

2. Technological evaluation:-

2.1. Chemical composition:

Results of chemical composition of the fresh okra pods of the tested five genotypes are shown in Table (5). Moisture content varied from 83.82% to 86.12%. Values of moisture were lower than that mentioned by Inyang and Ike (1998); Soliman (1999); Kotb *et al.* (2000) and Wahba

(2005). On the side, Makhadmeh and Ereifej (2004) found values somewhat in accordance with those reported in the present study. Highly significant differences are shown in crude protein content among the five studied genotypes. These results are in agreement with most of okra genotypes examined by Makhadmeh and Ereifej (2004) and lower than that mentioned by Inyang and Ike (1998).

Table 5: Chemical composition of the tested five okra fruit genotypes.

Parameters (%)	Genotypes					LSD (0.05)
	Alexandria 1 M ± SD	Alexandria 2 M ± SD	Line 1 M ± SD	Line 2 M ± SD	Line 3 M ± SD	
Moisture content	84.21±0.34	85.26±0.42	83.82±0.23	86.12±0.72	84.40±1.09	1.32
Crude protein*	18.17±0.35	18.90±0.43	19.60±0.18	21.33±0.10	19.60±0.2	0.50
Crude fiber*	10.70±0.1	10.70±0.45	12.83±0.50	10.30±0.4	14.75±0.53	0.71
Ether extract*	2.31±0.07	1.95±0.04	2.98±0.05	2.07±0.07	1.97±0.03	0.10
Ash*	9.44±0.34	11.67±0.27	11.49±0.06	11.57±0.15	10.60±0.32	0.48
Carbohydrate**	59.38±0.54	56.78±0.27	53.10±0.74	54.75±0.39	53.08±0.55	0.95

*On dry weight basis. ** By difference.
M ± SD ; Mean ± standard deviation.

Crude fiber content varied, significantly, among genotypes. It ranged from 10.30 for line 2 to 14.75% for line 3. All genotypes had higher fiber content than those reported by Mohamed *et al.* (1994) and Inyang and Ike (1998) and lower than that mentioned by Longe *et al.* (1982). Genotypes examined by Makhadmeh and Ereifej (2004) showed a wide range of crude fiber content (8.76 to 22.34%) than that mentioned here. Fiber content in okra fruit is an important quality attribute where higher fiber content of genotype is related to progress in age.

Crude ether extract content varied, significantly, among genotypes. Whereas, it ranged from 1.95% for cultivar "Alexandria 2" to 2.98% for "line1". Makhadmeh and Ereifej (2004) examined genotypes of okra that had higher content and others had lower content of fat than found here. The results, also, show that ash content had significant differences among the five studied genotypes. It ranged from 9.44 to 11.67% for the cultivars "Alexandria 1" and "Alexandria 2", respectively. These results are higher than that mentioned by Longe *et al.* (1982), Inyang and Ike (1998) and Makhadmeh and Ereifej (2004).

Carbohydrates represented the major component on dry weight basis. Cultivar "Alexandria 1" had the highest carbohydrates content (59.38%) followed by "Alexandria 2" (56.78%). On the other hand, "line 1" was found to have the lowest carbohydrate content (53.1%) as compared with the other investigated genotypes. Our results are in accordance with those found by Makhadmeh and Ereifej (2004).

2.2. Physicochemical parameters:-

Results of the physicochemical parameters of the five okra pods genotypes are shown in Table (6). The statistical analysis indicates that there were such significant differences among the tested five genotypes regarding ascorbic acid content. It is obvious that cultivar "Alexandria 2" had the highest content of ascorbic acid (20.96 mg/100g fresh pods) and Line 2 had the lowest value (13.00 mg/100 g fresh pods). Ekinci and Kilic (1994) stated that ascorbic acid content in okra was within the range above mentioned. On the other hand, Wahba (1991); Inyang and Ike (1998); Giannakourou and Taoukis (2003) who found that ascorbic acid contents of okra pods were; 22.60, 28.60 and 28.00 mg/100g fresh pods, respectively.

Table 6: Some physicochemical parameters of the tested five okra fruit genotypes.

Parameters	Genotypes					LSD (0.05)
	Alexandria 1	Alexandria 2	Line 1	Line 2	Line 3	
	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	
Ascorbic acid (mg/100g)	17.25±1.03	20.96±0.96	14.07±0.35	13.00±0.24	14.52±0.86	1.47
Mucillage(%)	3.38±0.12	3.77±0.20	3.80±0.02	3.96±0.34	3.97±0.24	n.s
Chlorophyll (mg/L)						
a	8.71±0.37	12.64±0.29	7.97±0.30	8.51±0.40	9.21±0.19	0.58
b	4.34±0.17	5.21±0.18	4.65±0.19	4.22±0.11	4.53±0.17	0.31
Total chlorophyll (mg/L)	13.06±0.04	17.85±0.04	12.63±0.31	12.73±0.11	13.74±0.05	0.28

M ± SD = Mean ± standard deviation. n.s.= not significant

Results of Table (6) show no significant difference was detected regarding the mucillage content of the tested five okra genotypes. The mucillage content varied from 3.38 mg dry weight/100g fresh pods in cultivar "Alexandria.1" to 3.97 in "line 3" .These results agree well with those obtained by Kotb *et al.* (2000) and Wahba (2005) but lower than that mentioned by Ragheb *et al.* (1995), Soliman *et al.* (1999), and Kotb *et al.* (2000).

Chlorophyll (a) content of the five genotypes ranged from 7.97 for "line 1" to 12.64 mg/L for "Alexandria 2", while chlorophyll (b) ranged from 4.22 for "line 2" to 5.21 for "Alexandria 2". Cultivar "Alexandria 2" had the highest content of chlorophyll a and b. Therefore the total chlorophyll content varied between 12.73 to 17.85 mg/L, respectively.

The variations in chemical composition and physicochemical parameters between our results and those reported in literatures may be attributed to genotype and agricultural factors.

2.3. Effect of storage on the quality of frozen okra pods.

2.3.1. Chemical composition :

As shown from Figure (1), there were significant differences in chemical composition between the fresh and the frozen okra pods at zero time of storage. It can be noticed that the pretreatment of freezing (blanching in boiling water for two minutes was the cause of these significant differences). The moisture content increased slightly due, possibly, to absorption of water during blanching. Also, protein content (on dry weight basis) increased, slightly, at zero time of storage. According to Inyang and Ike (1998) the blanching temperature may cause the coagulation, aggregation, and insolubilization of the proteins while other constituents were leached out thereby leading to increase it. Ether extract, ash, and carbohydrates decreased slightly at zero time of storage. This finding may be due to leaching out of some of the constituents into the blanching medium. The previous observations are in agreement with those found by Inyang and Ike (1998). It was noticeable that freezing procedure had no effect on crude fiber content. This result may be due to the insolubility of this component in water. Also, Fig. (1) shows that the storage period (9 months) had no effect on the chemical composition of okra pods.

2.3.2. Physicochemical parameters of okra pods:

Vegetables are a major source of ascorbic acid, a nutrient that besides its vitamin action is valuable for its antioxidant effect (Hussein *et al.*, 2000). During processing, distribution, and storage of frozen vegetables; ascorbic acid could be oxidized to dehydroascorbic acid, which irreversibly hydrolyzed to 2,3-diketogulonic acid, which has no vitamin C activity. This oxidation is enhanced by temperature abuses during frozen storage (Favell, 1998). However, Fig. (2a) represent ascorbic acid content of fresh and frozen stored okra pods for the tested five genotypes. It was observed that the pre- treatment of freezing and the storage time had dramatically affected ascorbic acid contents of all tested genotypes. Ascorbic acid content of cultivars "Alexandria 2" and "Alexandria 1" that had

the highest values (20.96and17.25mg/100g, respectively) was decreased to be 14.47 and 14.87mg/100g, respectively, after the pre-treatment then reached 6.35 and5.08mg/100g,respectively, at the end of storage period. Vitamin C is a heat-labile and water-soluble vitamin and losses due to food processing have been reported (McErlain,et al.,2001) Significant differences were noticed among all periods of storage in the five okra genotypes. Katsaboxakis and Papanicolaou (1996) found that during freezing of fresh okra around half of its initial L-ascorbic acid content was reduced. The rate of decrease was different among the genotypes and storage period.

Okra pods are highly mucilaginous. Sliminess is a layman's term for the sticky or viscid fluid secreted by fresh okra upon cutting or blending (Uzo and Ojiako, 1980). As shown from the same Fig. (2:b), mucilage content decreased by freezing process, while frozen storage had no effect on it. Statistically, mucilage content of okra pods of the five genotypes was significantly affected by the freezing process [blanching as a pretreatment before freezing]. On the other hand, insignificant effect was incident during storage period. The mucilage content of "line 3" that had the highest value(3.97 mg dry weight/100g fresh pods) was decreased to be 3.51 mg dry weight/100g fresh pods after the pre-treatment. This value was stable till the end of storage. Blanching in hot water led to a slight decrease in viscosity of fresh okra pods. Since mucilage and gums are water-soluble polysaccharides, the decrease in viscosity could be attributed to leaching out of okra mucilage into blanch water (Inyang and Ike, 1998).

The effect of blanching, freezing processes and frozen storage time on the chlorophyll content of the five genotypes of okra are shown in Fig (2:c,d, and e). Statistically, there were significant differences in chlorophyll content (a and b) during frozen storage. The loss of chlorophyll a and b at zero time storage would be due to the heat of blanching (Schwartz and Vonelbe, 1983; Faboya, 1985) and freezing process. This loss was continued during frozen storage. These changes were probably due to the conversion of chlorophyll to phaeophytin (Schwartz and Lorenzo, 1991). Data show that the rate of chlorophyll a degradation was higher than that of chlorophyll b during storage time.

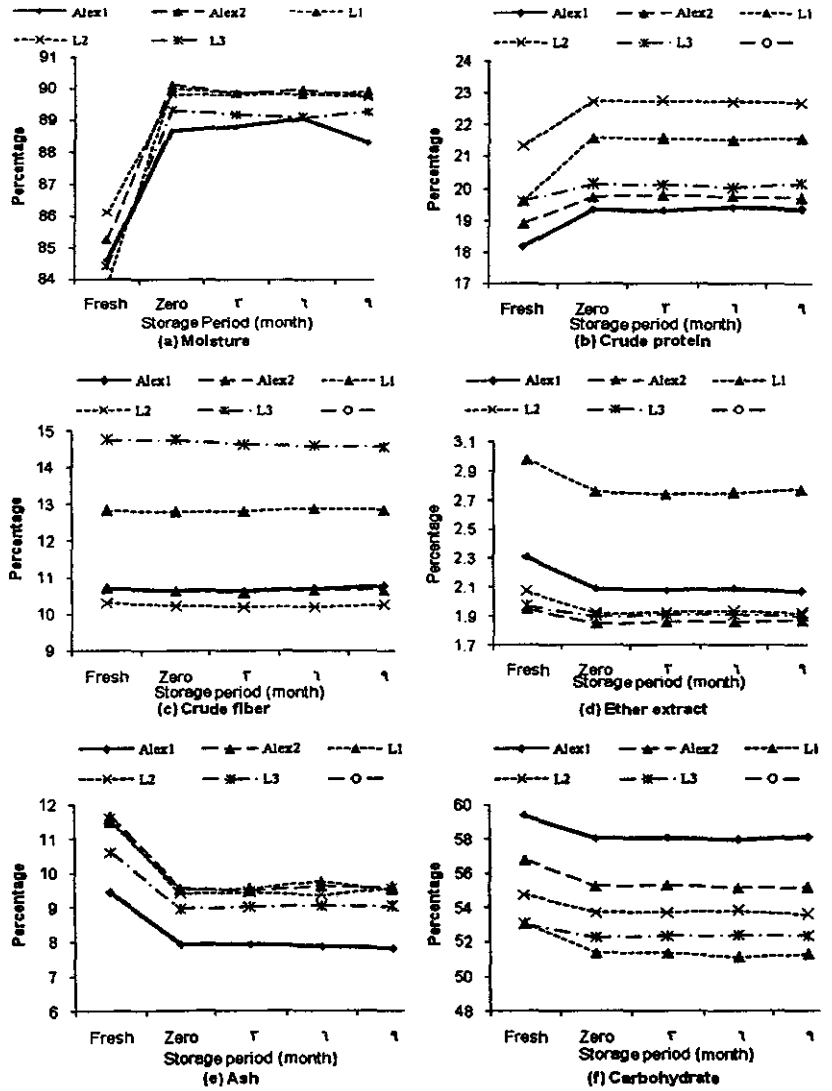

Fig.(1): Effect of freezing process and frozen storage on chemical composition of the tested five okra fruit genotypes.

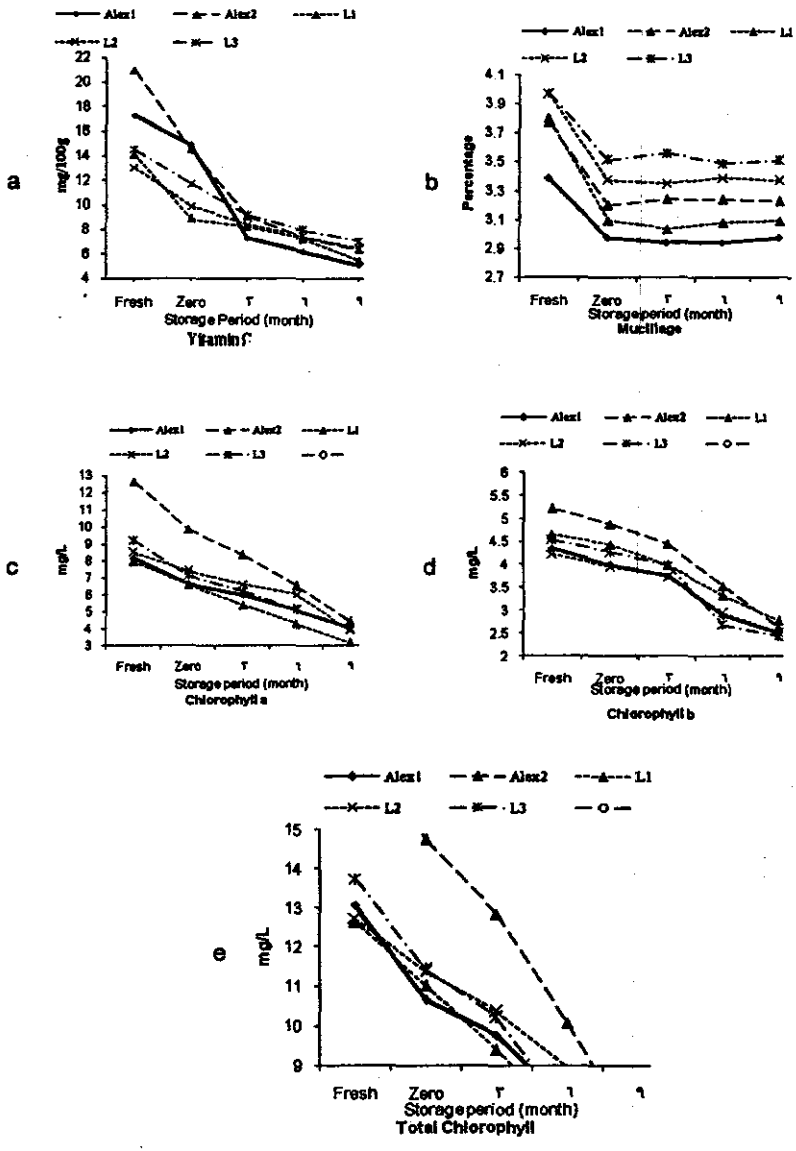

Fig. (2): Effect of freezing process and frozen storage on some physicochemical parameters of okra pods.

2.4. Sensory properties of cooked okra pods:-

Results of Table (7) revealed that panelists accepted all the samples of cooked okra pods whether fresh or after 9 months frozen storage. They preferred cooked fresh "line 2" then "line 1", "line 3" and "Alexandria1" and finally "Alexandria 2" had the lowest scores of appearance and taste, causing the overall acceptability to be only acceptable. There were significant differences between the fresh samples in appearance and taste. After frozen storage, all the samples were described as very acceptable without no significant differences between them in all the tested organoleptic properties.

Table 7: Mean sensory scors values of the five genotypes of cooked fresh okra pods and after 9 months of frozen storage.

Tested Genotype	Organoleptic properties						Overall acceptability
	Appearance	Colour	Odour	Texture	Hardness	Taste	
				Cooked fresh			
Alexandria 1	8.6±0.55	8.4±0.55	8.4±0.55	8.0±1.22	8.6±0.65	8.4±0.55	Very acceptable
Alexandria 2	6.4±0.89	7.2±1.1	7.2±1.10	7.8±1.1	7.6±0.72	6.0±0.00	Acceptable
Line1	7.2±1.10	8.0±1.22	8.0±1.22	8.0±0.00	7.6±1.12	8.0±0.0	Very acceptable
Line2	8.8±0.45	8.6±0.55	8.4±0.55	8.2±1.30	8.8±0.56	8.0±1.22	Extremely acceptable
Line3	7.6±0.89	8.4±0.55	8.4±0.55	7.4±1.34	7.6±1.23	7.4±1.34	Very acceptable
L.S.D (0.05)	0.98	n.s	n.s	n.s	n.s	1.11	
				Cooked frozen			
Alexandria 1	7.6±0.63	8.0±1.07	7.6±1.11	8.0±1.12	7.8±1.32	7.2±1.22	Very acceptable
Alexandria 2	7.2±1.03	7.8±1.04	8.4±0.77	8.2±1.05	8.8±1.06	7.6±0.81	Very acceptable
Line1	8.8±1.02	8.6±1.07	8.2±0.72	8.6±0.89	8.2±1.33	8.2±0.85	Very acceptable
Line2	8.2±0.45	8.2±1.12	8.2±0.56	8.8±0.78	8.6±1.07	8.2±1.09	Very acceptable
Line3	7.4±0.57	8.2±0.95	7.4±0.45	8.4±0.77	8.8±0.56	7.4±0.12	Very acceptable
L.S.D (0.05)	n.s	n.s	n.s	n.s	n.s	n.s	

M ± SD = Mean ± standard deviation. n.s.= not significant

REFERENCES

Abd-Allah, S. A. M. and Mansour, S. M. A. 2005. Selection for Yield and Its Components in Okra (*Abelmoschus Esculentus* L. Moench). J. Adv. Agric. Res. (Fac. Agric. Saba Bash), 10(4):409-418.

Abo El-Anen,M.A. 1982. The impact of using different kinds of appliances and fuel on food preparation and quality. M.Sc. Thesis In Home Economic, Faculty of Agriculture, Alexandria University.

Adom,K.K.; V.P. Dzogbefia; and W.O. Ellis 1997. Combined effect of drying time slice thickness on the solar drying of faba. J. Sci. Food Agric. 73:315-320.

Association of Official Analytical Chemists (AOAC) 1995. Official Methods of Analysis of the Association of Official Analytical Chemists. 16th ed., Virginia, USA.

Dospekhov, P.A. 1984. Field Experimentations Statistical Procedures, Mir publishers Moscow, pp. 349.-352

Ekinci,A. and O. Kilic 1994. Influence of some pretreatments on the quality of frozen okra. GIDA, 19(4):243-248.

FAO 2003. FAO stat Database. Avaiable from: http://faostat.fao.org

Faboya,O.O. 1985. Chlorophyll changes in some green leafy vegetables during cooking. J.Sci.Food Agric.36:740-744.

Favell,D.J. 1998. A comparison of the vitamin C content of fresh and frozen vegetables. Food Chem. 62:59-64.

Giannakourou, M.C. and K.S. Taoukis. 2003. Kinetic modelling of vitamin C loss in frozen green vegetables under variable storage conditions. Food Chem. 83:33-41.

Hussein,A.; J.A.Odumeru; T. Ayambadejo; H. Faulkner; W.B. Mcnab; H. Hager; and L. Szyarto 2000. Effect of processing and packaging on vitamin C and β-carotene content of ready-to-use (RTU) vegetables. Food Res. International. 53:131-136.

Inyang, U.E. and C.I. Ike 1998. Effect of blanching, dehydration method and temperature on the ascorbic acid, colour, sliminess and other constituents of okra fruit. Int. J. of Food Sci. and Nut. 49:125-130.

Katsaboxakis, K. and D. Papanicolaou 1996. Loss of ascorbic acid in some fruits and vegetables during quick freezing. Sci. Aliments, 16:133-141.

Kotb,F.K.; R.M. Wahba; and W.S. Ragheb 2000. Horticultural, food standards and susceptibility to infestation with some insect pests for some new lines of okra (*Abelmoschus esculentus* L. Moench). J. Agric. Sci. Mansoura Univ., 25:5901-5909.

Longe,O.G.; B.L. Fetuga; and M.E. Aken'ova 1982. Changes in the composition and carbohydrate constituients of okra (*Abelmoschus esculentus*, Linn.) with age. Food Chemistry,Vol.8:27-32.

Makhadmeh,I.M. and Kh.I. Ereifej 2004. Geometric characteristics and chemical composition of okra (*Hibiscus esculentus* L.) grown under semi-arid condition. Int. J. of Food Properties. 7:83-90.

McErlain,L.; H. Marson; P. Ainsworth; and S.A. Burnett 2001. Ascorbic acid loss in vegetables: adequacy of a hospital cook-chill system. In. J. Food Sci. Nutr. 52:205-211.

Mohamed,M.H.; M.S. Abd El-Monem; F.A. Abd El-Bary; and S.Z. Hegazy 1994. Effect of crossing on the immature pod characteristics of okra hybrids. Annals Agric. Sci., Ain Sams Univ., 39:329-336.

Moran,R. and D. Porath 1980. Chlorophyll determination in intact tissues using N,N-dimethylformamide. Plant Physiol. 65:478-479.

Ragheb,W.S.; S.D. Rofael; and A.I. Ismail 1995. Performance of some promising breeding lines of okra (*Abelmoschus esculentus* L. Moench) and their relation to food processing. Com. In Sci. and Dev. Res., 50:127-140.

Ranganna, S. 1977. Manual of analysis of fruit and vegetable products.McGraw.Hill Book Pub.Co.Ltd.,New Delhi.

Schwartz, S.J. and T.V. Lorenzo 1991. Chlorophyll stability during continous aseptic processing and storage. J. Food Sci. 56:1059-1062.

Schwartz, S.J. and J.H. Vonelbe, 1983. Kinetics of chlorophyll degradation to pyropheophytin in vegetables. J. Food Sci. 48:1303-1306.

Singh,B.P.; D.K. Bhatnagar; and O.P. Gupta 1978. Effects of growth retardation and wax emulsion on the shelf-life of okra. Haryana J. Hort. Sci. 7:91-94.

Soliman, Kh,A. 1999. Postharvest quality of newly produced genotypes of okra (*Abelmoschus esculentus* L. Moench). J. Agric. Sci. Mansoura Univ., 24(8):4161-4169.

Steel,R.G.T. and J.H. Torrie, 1980. Principles and procedures of statistics.Mc Graw-Hill Book Comp, Inc. New York,U.S.A.

Uzo,JO.and G.U. Ojiako 1980. A physical method for measuring okra fruit quality.J.Food Sci.45:390-392.

Wahba, R.M. 1991. The nutritive value and cooking quality of okra fertilized with trace elements. Ph.D. Thesis. In Home Economic,Faclty of Agriculture, Alexandria University.

Wahba, R.M. 2005. Promising lines of okra (*Abelmoschus esculentus* L. Moench) after eight generations of inbreeding and selection. J. Adv. Agric. Res. (Fac. Agric. Saba Bash), 10(2):409-418.

Woolfe,M.L.; F.C. Martin; and G. Otchere 1977. Studies on the mucillages extracted from okra fruits and Baobab leaves. J. Sci. Food. Agric. 28:519-529.

الملخص العربى

التقييم البستانى والتكنولوجى لخمسة تراكيب وراثية جديدة من الباميا

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أجريت هذه الدراسة فى ثلاثة مواسم متتابعة فى أعوام ٢٠٠٥ ، ٢٠٠٦ ، ٢٠٠٧ بمحطة بحوث البساتين بالصبحية – الإسكندرية. وقد تم تقييم الخواص الكيماوية للقرون بالإضافة الى تقييم بعض الصفات الطبيعية وبعض الخواص الحسية. أيضا تمت دراسة تأثير عملية التجميد وظروف التخزين تحت التجميد على خواص القرون . وقد أوضحت النتائج أن الصنف اسكندرية ٢ قد أعطى أعلى متوسطات للوزن القابل للأكل من القرون، وقطر القرن والمادة الجافة ، بينما أعطى الصنف اسكندرية ١ والسلالة ١ أطول القرون . لكن أعطت السلالة ٢ أقصر القرون. فى حين اعطت السلالة ١ أرفع القرون كما أنها اعطت اعلى محصول كلة من القرون . أظهر التحليل الاحصائى أن هناك فروقا معنوية بين التراكيب الوراثية فيما يتعلق بكل الصفات التى تم قياسها وفى معظم المناطق التى اختبرت فيها تلك التراكيب الوراثية. وكانت هناك فروقا معنوية بين تلك التراكيب الوراثية فيما يتعلق بتركيبها الكيماوى . لم يكن بينها فرق معنوى فى محتواها من المادة المخاطية ، لكن بالنسبة لباقى الصفات الكيموفيزيائية (حمض الأسكوربيك ، الكلوروفيل) فقد اختلفت هذه التراكيب الوراثية فيما بينها معنويا. واتضح أن المعاملة المبدئية قبل التجميد (السلق فى الماء) كانت سببا فى زيادة البروتين وكذلك نقص الرماد والكربوهيدرات والمستخلص الأثيرى. ولم يكن لعملية التجميد تأثير على محتوى القرون من الألياف الخام . واوضحت النتائج أن التخزين تحت التجميد لمدة تسعة أشهر لم يكن له تأثير على التركيب الكيماوى لقرون الباميا ، إلا أنه لوحظ أن هناك نقصا فى محتوى القرون من حمض الأسكوربيك والكلوروفيل . كما أن محتوى القرون من المادة المخاطية لم يتأثر بالتخزين تحت التجميد . وقد تقبل فريق التذوق كل العينات من التراكيب الوراثية الخمسة الطازجة أو المخزنة لمدة تسعة أشهر تحت التجميد وذلك بعد طبخها.