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EFFECT OF PRE-PROCESSING TREATMENTS ON THE QUALITY OF COOLED AND FROZEN GREEN BEANS

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ABSTRACT

Green beans pods variety *Bronco* were stored at 7°C with relative humidity 95% - 97% on two packages of polyethylene bags (proved with antilog agents) and perforated poly polypropylene from zero time to 14 days. After post harvest treatment , green beans pods were cut crosswise into length of 2cm , which were given short heat treatment and afterward stored in polyethylene bags for a period of 6 months at -18 °C. Storage time and type of package before processing had an effect on the texture, color, chlorophyll a and b, ascorbic acid and carotenoids of frozen green beans. The texture of frozen samples was highly correlated with water loss of the raw green beans. Significant correlations were found between yellowness, instrumental color measurements and chlorophylls in the frozen samples. Ascorbic acid content of green beans during storage at-18 °C decreased by 12% during 3 months of storage. A correlation existed between the rate of decrease and the storage time of raw green beans before frozen storage and type of packaging material. Carotenoids content of green beans was stable during stored at 7°C, and remained stable during subsequent frozen storage.

Finally , it could be concluded that the content of chemical compounds decreased when green beans were stored for 14 days at 7°C or after processing for freezing as well as, the loss in sensory qualities was the major factor of deterioration.

INTRODUCTION

Green beans, known also as snap beans (*Phascolus vulgaris L.*), is the second Egyptian vegetable crop grown for local consumption and export (Anon, 2005). Resurrection *et al.* (1987) considered the main criteria for determining the shelf life of vegetables to be the degradation of vitamin C and the loss of palatability including sensory characteristics such as color, flavor and textural parameters. Deterioration of quality attributes occurs commonly during post harvest handling of the fresh product. Weight loss is cumulative and generally linear with time during storage. The increase in limpness and shriveling and subsequently the loss of crispness followed by weight loss of green beans (Jimenez *et al.*, 1998). Green beans are harvested at an immature developmental stage, having a high respiration rate and a short storage life, only 7-10 days at 5-8 °C (Cantwell and Kasmire, 2002). The freezing process has made possible the preservation of seasonally available fruits and vegetables for later use in a convenient, high- quality form. Freezing is the most satisfactory method of preserving foods, which color texture and nutritive value which usually retained compared with other methods of food preservation. However frozen vegetables must first be blanched to inactivate the associated enzymes otherwise minor chemical constituents especially those related to flavor will be lost during storage (Splittstoesser , 1979).

The aim of this study was to assess the effects of storage conditions of raw green beans before processing on the nutritional and sensory qualities of green beans immediately after processing and during subsequently frozen storage.

MATERIALS AND METHODS

Materials and storage conditions .

Experiment 1:

The green beans (*Phascolus vulgaris L.*), pods C.V. Bronco were obtained from a local farm at Giza during 2006 season. The beans were brought to the laboratory within few hours from harvesting and stored at 7°C overnight with relative humidity (95–97%). In the next day, the green beans were packed in two different packages of perforated polypropylene and polyethylene bags (Egyptian film, prepared with antifog agents) and sealed. The unpackaged beans were placed in an open tray. The samples were kept at 7°C in a refrigerator with relative humidity of 95 - 97% . Same properties were evaluated at the beginning and after 7, 14 days of storage. These properties were weight before and after storage , the weight loss (calculated as %) and color.

Experiment 2:

After the post harvest treatment, the raw green beans were washed, chopped and cut crosswise into length of 2.5 cm., then blanched in hot water at 85 °C for 2 min. The blanched samples were packaged in polyethylene bags (proved with antifog agents) of approximately 250 g capacity. These samples were frozen and kept in a freezer at - 18°C . The frozen samples were analyzed at intervals for 6 months which were left to thaw in their individual bags for 14 hrs. in a refrigerator at 7 °C. Sensory evaluation was carried out as well as, surface color (Hue angel).Total chlorophyll and ascorbic acid contents were also determined.

Analytical Methods:

Dry matter, weight loss, crude fibers and ascorbic acid contents were determined according to the methods described by the AOAC (2000). Dietary fibers fractions, neutral detergent fibers (NDF), acid detergent fiber (ADF), lignin, hemicelluloses and cellulose, were determined according to the methods described by Goering and Vansoest (1970). Chlorophylls A, B and carotenoids were determined according to the methods described by Wettestein (1957), using the following equations:

Chlorophylls A= (9.784 × E662)- (0.99 × E 644) mg/ l000g.

Chlorophylls B = (21.426×E644) – (4.65 × E 6621) mg/l000g.

Carotenoids = (4.695×E440) – (0.268) × (GL A-B) mg/ l000g.

The surface color of the raw and frozen green beans were measured using the Hunter lab color Difference Meter (Hunter lab model D P – 9000). Color was expressed as hue angle ($\tan^{-1}$ a/b) in which hue angle is related to greenness yellowness of the green beans.

Sensory evaluation:

A sensory panel test was conducted on fresh and storage samples at zero time and after 7 , 14 days of storage at 7 ^{o}C . The visual evaluation was for off-odor, firmness and turgidity. Visual quality was scored from 9 to 1 scale where 9= excellent, 7= good, 5 = fair , 3 = poor, 1= un usable according to the method described by Jimenez *et al.*, (1998). Firmness and turgidity were evaluated on a scale from 5 to 1, where 5= firm and turgid , 4= firm, 3= Moderately firm, 2= limp and shrivel, 1=More (Jimenez *et al.* ,1998). Off-odor was evaluated on a scale from 5 to 1, where 5= severe , 4 = Moderately sever, 3= Moderate, 2= slight, 1 = None (Kasmire *et al.*, 1974).

Also, five sensory characteristics namely, color, fibrous senses, flavor, texture and loss of skin, as a consequence of boiling, were evaluated. The extreme values of these scales are as follows. Fibrousness (1=non fibrous, 5=extremely fibrous), flavor (1= very weak green beans flavor, 5 = very strong green beans flavor), texture (1=very soft, 5 = very hard), skin loss (1= non- skin loss, 5= marked loss of skin) . color (1 = very light green), 5 = very dark green.

Statistical analysis

The results of organoleptic tests were analyzed by the analysis of variance (ANOVA) and least significant differences (L.S.D) using the procedure by Statistical Analysis System (SAS) program according to Steel and Torrie (1980). Significant differences were determined at the level p ≥0.05.

RESULTS AND DISCUSSION

Effect of packaging and storage period on shelf life of fresh green beans:

Shelf life and changes in pods quality of fresh green beans after storage at 7 ^{o}C and 95-97% relative humidity for a period up to 14 days were determined and the weight loss, visual quality , firmness and turgidity , off-odor and dry matter as affected by type of package as well as the storage period are shown in Table (1). As shown in the data presented in this table , it could be noticed that the lower weight loss occurred in samples polyethylene packaged was (0.12%). On the other hand, the perforated polypropylene package resulted in higher weight losses (2.37%) and still better than that of the unpackaged ones . With respect to these results for visual quality of green beans there was a significant interaction in visual quality of pods between the package material and storage period (Kader, 2002). For instance, while the sealed polyethylene package has maintained visual quality of samples for up to 7 days , after which it started to deteriorate within 7 days, for the other package. These results are in agreement with those reported by Cantwell and Kasmire (2002), who found that post harvest life of beans was only 7-10 days at 5-8C but in case of polypropylene package it was significantly better than the unpackaged sample. Concerning the firmness and turgidity, the results in Table (1) show also that a significant decrease in firmness and turgidity with prolonged storage for the two

packages and the unpackaged samples. On the other hand, the sealed polyethylene package has maintained firmness and turgidity for at least 7 day. These results are in agreement with those of Buescher and Adams (1979). For the sealed polyethylene package, perforated polyethylene package and unpackaged had no off-odor for 7 days. On the other hand, the average off-odor of unpackaged samples was sharply increased to the unacceptable value of (4.67) after 14 days of storage. Slight differences occurred in dry matter of green beans among the samples packaged in the two studied packages with prolonged storage. For the perforated polypropylene packages, dry matter was increased as the storage period reached 14 days. In contrast, a sharp significant increase occurred in dry matter for the unpackaged samples, after 7 days of storage. Since dry matter percentage depends on fresh weight, it is most likely affected by factors that cause loss in tissue moisture content. So, the increase in dry matter percentage may be due to water loss. These results are harmonized with those of Luh and Woodroof (1978), who found that moisture losses of vegetables and fruits during post harvest may be reduced by protective packaging.

Generally, from the aforementioned data, it could be concluded that the green beans quality attributes were influenced by packaging type and storage period and it had the highest reduced values in the unpackaged samples.

Table (1):Effect of different packaging materials on quality attributes of green beans during storage at 7 °C with relative humidity (95 – 97%).

Storage period (days)	Type of packaging materials	Weight Loss %	Visual quality	Firmness nd turgidity	Off-odor	Dry matter
Zero time	-	0.0	9.0	5.0	1.0	11.40
7 days	a) Unpackaged	4.71	7.00	4.00	1.00	10.94
	b) Perforated Polypropylene	2.37	9.00	5.00	1.00	11.40
	c) Polyethylene	0.12	9.00	5.00	1.00	11.61
14days	a) Unpackaged	19.77	1.00	1.00	1.00	13.37
	b) Perforated Polypropylene	14.56	1.67	1.00	1.00	12.03
	c) Polyethylene	0.52	7.00	4.33	4.67	11.53

Quality changes in green beans during six months of subsequent frozen storage:

Hue angle and chlorophyll have been used to express the degree of greenness and the development of yellowing during storage of specific vegetables .The data in Table (2) show that the hue angle($tan^{-1}b/a$) decreased slightly during storage of blanched green beans, but the lowest contents were observed after storage of the green beans at 7 °C for 14 days. On the other hand, the same data indicate that the change in color during storage was most closely correlated with the changes in chlorophyll which was a better predictor of visual color than the instrumental color values (Shewflet *et al.*,1983). Furthermore, the hue angle and chlorophyll of raw green beans were also correlated strongly to these quality characteristics in blanched pods before freezing compared to the un blanched sample

(Lurie,1998). Also, it could be noticed that weight changes gave an indication of loss of moisture and the content of chlorophyll which provides a measure of greenness in green beans. These results are in accordance with those of Lebrmann *et al.* (1968).

Nutritional quality

The effect of storage periods at -18 °C on ascorbic acid content of frozen green beans previously cold stored and blanched was studied and the results are presented in Table (2). The data in this table indicate that ascorbic acid content decreased by 12% during the first 3 months of frozen storage period. These results are in agreement with those of Harris and Karmas (1975). But in case of frozen samples without previous blanching the loss of ascorbic acid increased to 75% after the same period. These results are in accordance with those obtained by Luh and Woodroof (1978),who found that blanching decreased vitamins loss during freezing, the matter which served in keeping the qualities of vegetables pigments. Moreover, ascorbic acid content of green beans was affected greatly by the period of storage before freezing process which ascorbic acid was highly decreased the raw samples stored for 14 days.

Table (2):Effect of storage at -18 °C of green beans on hue angle, total chlorophyll, ascorbic acid and carotenoids.

storage time at 7°C (days)	Subsequent storage time of green beans at -18° c for											
	Hue angle			Chlorophyll (mg /100g) dry weight			Ascorbic acid (mg /100g) dry weight			Carotenoids (mg/1000 g)		
	zero Time	3 month	6 month	zero Time	3 month	6 month	zero Time	3 month	6 month	zero Time	3 month	6 month
0	a -51	bc -55.9	de 59.40	a 176.2	c 158.2	c 154.2	a 2054.8	cd 668.0	e 667.4	a 51.50	a 51.51	a 54.76
7	ab 53.8	c 56.71	afe 60.40	ab 172.3	bc 161.4	c 157.0	b 1166.1	d 815.1	f 529.3	a 57.17	a 57.17	a 55.53
14	cde 58.0	f 62.65	–	a 125.0	d 125.2	non	c -9343	a 814.8	non	a 52.50	a 52.51	non

Means within a column followed by different letters are significantly different (P < 0.05) , Non evaluated .

The effect of preparing and freezing processes at -18°C of green beans for 6 months on the dietary fibers fractions are presented in Table (3). The results in this table show that the neutral detergent fibers (NDF) content was higher than the acid detergent fibers (ADF) content. This could be attributed to the fact that NDF represents the total cell wall components including hemicelluloses, cellulose, lignin and cutin. Whereas, the (ADF) content determines only the cellulose, lignin and cutin. The difference is clearly due to hemicelluloses fraction. The same data shows that both NDF and ADF values within the freezing storage were decreased .Which reached to 19.16 and 7.35% in the end storage (6 months) . Also , the results indicated that hemicelluloses fraction was greatly affected by processing and storage period whereas , both cellulose and lignin were slightly decreased . Also, it was observed that green beans crude fibers percentage ranged from 12.72

to 4.10% . These differences may be due to the storage time before and after freezing as well as to the method of preparing samples before freezing . On the other hand , the (NDF) values were higher than the crude fibers values .These results are in agreement with those of Van-Soest and McQueen (1973) , who found that crude fibers did not a good estimation of the total amount of fibers percent .Conclusively , dietary fibers of plant foods is currently receiving such attention as an essential nutrient that has beneficial effects on hypercholesterolemia and various intestinal disorders.

Table (3): Effect of processing and freezing storage at -18°C for 6 months on green beans dietary fibers fractions .

Dietary fibers fractions	Storage time (days)	Effect of freezing storage on dietary fibers fractions			
		Raw Materials	Zero time	3 Months	6 Months
N D F	Zero time	27.50	26.54	22.15	16.11
A D F		14.15	18.28	16.31	13.25
Lignin		2.71	2.69	1.60	0.60
Hemicelluloses		8.35	7.77	5.50	2.50
Cellulose		16.47	16.15	13.01	11.10
C F		12.72	10.63	9.00	6.15
N D F	7 days	27.50	25.11	20.35	13.15
A D F		19:15	15.13	15.06	10.17
Lignin		2.71	1.90	0.81	0.45
Hemicelluloses		8.35	6.50	3.90	1.11
Cellulose		16.47	14.20	11.56	6.15
C F		12.72	14.21	7.81	4.01
N D F	14 days	27.50	19.10	15.10	19.16
A D F		19.16	11.12	11.12	7.35
Lignin		2.71	0.75	0.56	0.12
Hemicelluloses		8.35	4.60	1.56	0.56
Cellulose		16.47	12.60	7.91	5.10
C F		12.72	10.15	4.51	4.10

*(on dry weight bases),CF: Crude fibers ,NDF: neutral detergent fibers, ADF: acid detergent fibers.

Sensory evaluation of frozen green beans:

Sensory properties of unblanched and blanched frozen green beans after being stored at7°C for 7days are given in Table (4). After zero time, 7 and 14 days of storage period at 7 °C, all the pods were rated as edible. Samples which were stored frozen as raw green beans pods for 14 days and as blanched pods for 6 months were the only samples, which were not evaluated because they had a strong off-odor and were tainted (data not shown). So, the results of sensory evaluation of stored frozen green beans at -18°C for 6 months after storage freshly at 7°C for 7 days were included only. Table (4) shows the means of the scores awarded of the statistical test applied. From the above table, no significant differences could be observed regarding fibrousness and flavor. With respect to color only the sample analyzed after 6 month differed significantly .The loss of skin increased as the

storage period prolonged. With respect to texture although there are significant differences, in general it continued acceptable being neither too soft nor too hard. On the other hand, blanched process, unblanched and storage periods had an effect on sensory properties.

Generally, according to the results of the present study, green beans must be stored in satisfactory conditions before processing. The factors influencing the quality of deep frozen vegetables were the post harvest, packaging type and the pre-processing such as heat treatment . Resurrection *et al.* (1987) considered the degradation of vitamin C and the loss of palatability including sensory characteristics such as color, flavor and textural parameters, in which the taste parameter, to be the main criteria for determining the shelf life of vegetables.

Table (4): Sensory valuation of green beans frozen at (-18°C) after being storage at 7°C for 7 day.

Sensory characteristics	Fresh Samples	Beans frozen at -18°C for						Significantly test
		Zero time		3 months		6 months		
		Un- blanched	blanched	Un-blanched	blanched	Un-blanched	blanched	
Color	a 3.9	a 3.4	b 3.7	b 2.9	ab 3.4	a 3.8	a 3.7	P<0.05
Fibrous senses	1.5	1.2	1.4	1.2	1.4	1.6	1.6	ns
Flavor	2.4	3.2	2.7	1.5	3.2	2.7	2.6	ns
Texture	ab 3.2	b 3.3	ab 3.1	a 2.6	a 2.6	zb 2.9	ab 2.7	P<0.05
Skin loss	a 1.0	a 1.1	a 1.5	b 1.9	ab 1.3	2 . 1	ab 1.7	P<0.05

a, b means the same letter indicate non significant difference between those mean within a row. Ns: not significant.

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تأثير معاملات ما قبل التصنيع على جودة الفاصوليا الخضراء المبردة والمجمدة

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في هذه الدراسة تم تخزين الفاصوليا الخضراء صنف Bronco على7°م في عبوتين من البولي إثيلين (المضاد للشبورة) والبولي بروبلين (المثقبة) لمدة ١٤ يوم بعد المعاملة بالتبريد ، تم تقطيع الفاصوليا الخضراء بالطول (٢سم) و تم تعريضها للمعاملة الحرارية و خزنت في أكياس من البولي إثيلين لمدة ٦ شهور. وأثبتت النتائج المتحصل عليها أن وقت التخزين بالتبريد ونوع العبوة قبل التصنيع كان له تأثير على القوام، اللون، والكلوروفيل، حمض الإسكوربيك ، الكاروتينات للفاصوليا الخضراء المجمدة. وأظهرت النتائج أيضا أن أفضل عبوة للمحافظة على جودة الفاصوليا الخضراء الطازجة هي البولي إثيلين (التي تحتوى على مواد مضادة للشبورة) حيث حافظت على اللون والمغذيات الأخرى. وقد دلت النتائج على أن الكاروتينات ظلت ثابتة أثناء التخزين بالتبريد والتجميد. كما أثبتت الدراسة أيضا أن أنسب وقت للمحافظة على هذه الجودة يجب ألا يزيد عن ٧ أيام تخزين على درجة ٧° م ورطوبة نسبة ٩٥%". أوضحت النتائج أيضا" أن تخزين العينات الطازجة لمدة ١٤ يوم على نفس ظروف التبريد السابقة أو بعد عملية التجميد لها أدى إلى نقص واضح في المكونات تحت الدراسة و الخواص الحسية أيضا".