EFFECT OF FREEZING ON NUTRITIONAL QUALITY OF BUSH BEAN AT DIFFERENT POD AGE STAGES

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ABSTRACT

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An experiment was conducted at the Agronomy Research Farm and laboratory of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, during December 2004 to March 2005 to investigate the effect of freezing on nutritional quality of bush bean at different pod age stages. Four bush bean genotypes viz; V_1, V_2, V_3 and V_4, three different pod age stages (10, 15 and 20 days after pod initiation), blanched at 50^0c for 5 minutes, frozen condition (-20^0c temp) quality was observed at 20, 40 and 60 days after freezing. The highest (40.08%) ascorbic acid retention observed in V_2 and the lowest was observed in V_1 at 20 days pod after 20 days of freezing. The highest (97.72%) protein retention was observed in V_3 at 20 days frozen condition and the lowest (70.29%) retention in V_4 at 60 days frozen condition. The highest dry matter retention (94.98%) was observed in V_1 at 20 days after freezing where loss was lowest. A slight decrease in total sugar content with the increase of freezing time was observed in all pod age stages. All the nutrients gradually decreased among the genotypes and pod age stages due to freezing. Ascorbic acid content sharply decreased at 20 days after freezing condition but after 40 and 60 days freezing ascorbic acid decreased at lower rate, other nutrients slightly decreased in all freezing condition.

Key words: Pod age, freezing conditions, nutritional quality, bush bean genotypes.

INTRODUCTION

Bush bean (*Phaseolus vulgaris*) is believed to be originated from Southern Mexico and Middle America (Evans, 1976). It is known by many names, such as French bean, common bean, kidney bean, shell bean, salad bean, green bean, haricot bean, wax bean, dry bean, field bean and snap or string bean (George, 1985). It is the most widely cultivated of all beans in temperate regions and is widely cultivated in subtropical regions. It is one of the most nutritious vegetable and consumed in great quantities all over the world. According to Shanmugacelue (1989) 100g of edible portion of pods contain on an average 1.7g protein, 4.5g carbohydrate, 1.8g fibre and minerals like Ca 50mg, Mg 29mg, P 28mg, and Fe 1.7mg.

Traditionally, green mature pods are eaten cooked with fish or fry with other vegetables; recently it is used with noodles and other introduced foods. In accordance with the common Bangladeshi recipes pods are suggested to harvest at green mature stage i.e. 7 to 15 days after pod initiation (Mazumdar, 2004). To get the maximum nutrition and to fulfill overseas market demand from this vegetable it is important to harvest pods at different age, as pod age is an important factor for organoleptic and nutritional qualities. We have just overcome the shortage of cereal but we are far from overcoming the nutritional shortage. A vast majority of our people is suffering from malnutrition. The average vegetable consumption in Bangladesh is only 51 g per head per day, against the FAO recommendation of 200g (Anon., 1991), which is the lowest in the South and South-East Asia (Rekhi, 1997). Availability is the major constraint of consumption and the availability of vegetables may be increased by minimizing the post harvest losses. Refrigeration storage or freezing can most effectively extend shelf life of vegetables and reduce post harvest losses by arresting metabolic breakdown and fungal deterioration of the commodity. In order to have good return and avoid marker glut it is essential to prevent post harvest losses. Under these circumstances freezing would be a good choice to store vegetables for longer duration at small-scale storage or for exporting purpose, as frozen foods are very common in overseas markets. Considering the above facts the experiment was designed to evaluate the nutritional condition of bush bean at different pod ages.

MATERIALS AND METHODS

The experiment was carried out in the laboratory of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, during December 2004 to March 2005. The soil type of the farm belongs to the Shallow Red Brown Terrace type under Salna Series of Modhupur Tract (Brammer, 1971; Saheed, 1984) of Agroecological Zone (AEZ) 28. The soil is characterized by silty clay with pH value of 6.5.

The climate of the farm is subtropical in nature characterized by heavy rainfall during June to September and scanty in winter with gradual fall of temperature from September.

The experiment was laid in Completely Randomized Design (CRD) with three replications. Four bush bean genotypes e.g. BB3 (Bush bean3), BB9 (Bush bean9), BB13 (Bush bean13) and BB15 (Bush bean15) were used as plant materials. Bush beans from all treatment combination were blanched at 50^0c for 5 minutes. Ascorbic acid (%), Total sugar (%), Protein (%) and Dry matter (%) were recorded on 10, 15 and 20 days after pod initiation. Bush bean genotypes were designated as, V_1=BB3, V_2= BB9, V_3= BB13, V_4= BB15 and there are pod age stages were designated as M_1=10 days after pod initiation, M_2=15 days after pod initiation, M_3=20 days after pod initiation

Ascorbic acid content was determined as per the procedure described by Pleshkov (1976). The total ascorbic acid content was quantified by using the following formula.

Ascorbic acid (mg/100g) = (T.F.V. 100)/Vw

Where

Titrate volume of KIO_3 ml

T=0.088 mg of ascorbic acid per ml of 0.001N of KIO_3

F=Total volume of the sample extracted

V=Volume of the extract (ml) taken

W=Weight of the sample taken (g)

Sugar contents were estimated according to Somogyi (1952), using Bertrand A, Bertrand B and Bertrand C solutions. Total sugar was calculated comparing tabulated values. Before calculation of total sugar factor of 0.4 $KMnO_4$ was determined.

Total nitrogen and protein content of the collected sample was determined by Kjeldahl method using $CuSO_4$ and K_2SO_4 mixture (1: 9) as catalyst.

The total nitrogen was calculated by the following formula:

$$\% N = 14.007 \times F \times (T-B) \times \frac{100 (ml)}{10 (ml)} \times 100/1000 \text{ w (g)}$$

Protein was estimated by multiplying 6.25 to the value of total nitrogen.

Dry matter (%) was calculated using this formula-

$$\% \text{ Dry matter} = \frac{\text{Dry weight}}{\text{Fresh weight}} \text{ x100}$$

Procedure of blanching

Fresh harvested bush bean was blanched in hot water bath. Bush bean was put into hot water and covers the pot. For immersion of bush bean Hot Water Bath was used. Blanching duration was counted from when the bush bean is immerged in hot water. One-gallon water was used for each pound of bush bean. The same water was used only two times because hot water can cause toughening of bush bean. Bush bean was cooled (to avoid boiling) immediately after blanching in pans of ice cold water for the same time used for blanching. Then bush bean was drained thoroughly.

Procedure of freezing

Blanched bush bean was packed in polyethylene bags and stored at frozen condition (-20^0C temp.). Quality was observed at 20, 40 and 60 days after storage.

Statistical Analysis

The recorded data were statistically analyzed with the help of MSTAT-C program. Treatment means were separated by DMRT at 5% level of significance.

RESULT AND DISCUSSION

Ascorbic acid

Percent retention and losses of ascorbic acid due to freezing are presented in Table 1. Ascorbic acid retention varied from 30.33 to 40.08, 15.77 to 33.53 and 5.41 to 17.84% among genotypes at 20, 40 and 60 days after

freezing, respectively. The highest (40.08%) retention was observed in V_2 and the lowest was observed in V_1. After 20 days of freezing the highest retention was found in 20 days old pod and the lowest was found in 60 days old pods. In case of interaction effect, retention percent was higher (42.55) in V_3 for 15 days old pods at 20 days after freezing. The lowest retention percent (4.58) was found in V_4 for 10 days old pods at 60 days after freezing. It was revealed that ascorbic acid retention was decreased due to increasing freezing duration. The most probable causes for loss of ascorbic acid during freezing might be due to improper handling and disturbance of freezing process (Petersen, 1993). During freezing the loss of ascorbic acid was reported to be 22% in *Capsicum annum* (Lisiewaska *et al.* 2000).

Table 1. Effect of freezing time (blanched at 50^0 C temp. for 5 min.) on ascorbic acid of bush bean genotypes at three pod age stages

Treatments	20 days		40 days		60 days	
Genotypes	Retention (%)	Loss (%)	Retention (%)	Loss (%)	Retention (%)	Loss (%)
V_1	38.24	61.76	17.24	82.76	5.41	94.59
V_2	40.08	59.92	33.53	66.47	17.84	82.16
V_3	30.33	69.67	24.92	75.08	8.52	91.48
V_4	31.27	68.73	15.77	84.23	6.56	93.44
Pod age						
M_1	31.38	68.62	19.53	80.47	7.5	92.5
M_2	34.85	65.15	19.32	80.68	7.86	92.14
M_3	34.83	65.17	22.66	77.34	8.4	91.6
Interaction						
V_1M_1	37.76	62.24	30.61	69.39	15.27	84.73
V_1M_2	38.78	61.22	32.04	67.96	19.80	80.20
V_1M_3	38.18	61.82	37.64	62.36	18.37	81.63
V_2M_1	20.26	79.74	14.74	85.26	4.84	95.16
V_2M_2	34.72	65.28	17.04	82.96	5.52	94.48
V_2M_3	35.06	64.94	19.61	80.39	5.77	94.23
V_3M_1	39.05	60.95	27.62	72.38	7.62	92.38
V_3M_2	42.55	57.45	20.21	79.79	9.04	90.96
V_3M_3	38.78	61.22	26.67	73.33	8.89	91.11
V_4M_1	29.17	70.83	15.83	84.17	4.58	95.42
V_4M_2	31.19	68.81	16.51	83.49	8.26	91.74
V_4M_3	34.00	66.00	15.00	85.00	7.00	93.00

M_1: 10 days after pod initiation, M_2: 15 days after pod initiation, M_3: 20 days after pod initiation,

Protein

Percent retention of protein gradually decreased with the increase of freezing duration (Table 2). Among genotypes, percent retention of protein varied from 92.99 to 97.72, 73.96 to 92.3817 and 70.29 to 78.17% at 20, 40 and 60 days after freezing, respectively. The highest retention (97.72%) was observed in V_3 at 20 days frozen condition and the lowest retention (70.29%) was found in V_4 at 60 days frozen condition. In case of pod age stages, the highest protein retention was found in 20 days pods and the lowest in 10 days old pods. In case of interaction effect, the highest retention (95.99%) was found in V_2 for 15 days old pods at 20 days after freezing. From this Table it may be concluded that protein retention decreased with the increase of freezing duration. This might be due to hydrolysis of protein and decrease in total soluble solids.

Table 2. Effect of freezing time (blanched at 50^0 C temp. for 5 min.) on protein of bush bean genotypes at three pod age stages

Treatments	20 days		40 days		60 days	
Genotypes	Retention (%)	Loss (%)	Retention (%)	Loss (%)	Retention (%)	Loss (%)
V_1	95.61	4.39	90.69	9.31	74.5	25.5
V_2	96.23	3.77	89.14	10.86	73.96	26.04
V_3	97.72	2.28	92.38	7.62	78.17	21.83
V_4	92.99	7.01	73.96	26.04	70.29	29.71
Pod age						
M_1	89.35	10.65	79.84	20.16	68.71	31.29
M_2	89.35	10.65	83.51	16.49	69.99	30.01
M_3	93.93	6.07	83.55	16.45	72.62	27.38
Interaction						
V_1M_1	92.96	7.04	85.16	14.84	70.08	29.92
V_1M_2	86.18	13.82	85.39	14.61	67.38	32.62
V_1M_3	93.41	6.59	87.89	12.11	74.73	25.27
V_2M_1	93.77	6.23	86.15	13.85	69.50	30.50
V_2M_2	95.99	4.01	92.44	7.56	82.27	17.73
V_2M_3	93.23	6.77	83.85	16.15	77.86	22.14
V_3M_1	90.72	9.28	84.62	15.38	69.11	30.89
V_3M_2	95.57	4.43	89.19	10.81	70.49	29.51
V_3M_3	96.11	3.89	93.33	6.67	73.85	26.15
V_4M_1	84.72	15.38	66.15	33.85	63.41	36.59
V_4M_2	82.72	17.28	67.97	32.03	63.44	36.56
V_4M_3	85.71	14.29	67.03	32.97	64.31	35.69

M_1: 10 days after pod initiation, M_2: 15 days after pod initiation, M_3: 20 days after pod initiation,

Dry matter

Dry matter retention and losses during freezing are presented in Table 3. The highest dry matter retention (94.98%) was observed in V_1 at 20 days after freezing where loss was lowest. At 40 days after freezing dry matter retention varied from 76.19 to 85.30% and at 60 days after freezing dry matter retention varied from 62.83 to 79.17%. Regarding pod age stages, 20 days pods contain higher retention percent of dry matter.

In case of interaction, the highest dry matter retention (100%) was found in V_3 at 15 and 20 days old pods. From the result it may be concluded that dry matter content gradually decreased with the increase in freezing. The loss of dry matter during freezing might be due to reduction of total solids.

Table 3. Effect of freezing time (blanched at 50^0 C temp. for 5 min.) on dry matter of bush bean genotypes at three pod age stages

Treatments	20 days		40 days		60 days	
Genotypes	Retention (%)	Loss (%)	Retention (%)	Loss (%)	Retention (%)	Loss (%)
V_1	94.98	5.02	85.30	14.70	79.17	20.83
V_2	94.15	5.85	78.80	21.20	70.66	29.34
V_3	94.72	5.28	76.77	23.23	62.83	37.17
V_4	86.79	13.21	76.19	23.81	69.51	30.49
Pod age						
M_1	87.41	12.59	76.05	23.95	64.68	35.32
M_2	94.82	5.68	77.38	22.62	68.46	31.54
M_3	95.82	4.18	84.49	15.51	77.8	22.2
Interaction						
V_1M_1	92.95	7.05	90.00	10.00	54.68	45.32
V_1M_2	95.00	5.00	90.48	9.52	80.30	19.70
V_1M_3	95.24	4.76	63.65	36.35	85.05	14.95
V_2M_1	86.21	13.79	86.21	13.79	72.69	27.31
V_2M_2	97.01	2.98	83.33	16.67	82.00	18.00
V_2M_3	97.31	2.69	85.90	14.10	84.83	15.17
V_3M_1	89.89	10.11	65.17	34.83	49.66	50.34
V_3M_2	100.00	0.00	78.89	21.11	71.33	28.67
V_3M_3	100.00	0.00	84.76	15.24	66.86	33.14
V_4M_1	77.22	22.78	69.62	30.38	63.54	36.46
V_4M_2	88.75	11.25	83.75	16.25	72.75	27.25
V_4M_3	95.00	5.56	90.00	21.11	80.30	27.56

M_1: 10 days after pod initiation, M_2: 15 days after pod initiation, M_3: 20 days after pod initiation,

Total sugar

Sugar content decreased in all genotypes during freezing except V_4. In V_4 sugar content increased slightly after 20 days of freezing (Figure 1A).

A slight decrease in total sugar content with the increase of freezing time was observed in all pod age stages (Figure 2B). Among pod age stages, 20 days old pods contained higher amount of sugar. In case of 60 days after freezing, 10 and 15 days old pods contained similar amount of sugar. From these figure it revealed that sugar content decreased due to increase of freezing time. It might be due to depletion of soluble sugar during cool storage. Rapid depletion of soluble sugar during cool storage (especially sucrose) was reported by Pogson & Morris (1997). They also point out that exhausted of sugar after 10 weeks at 1^0C storage. Similar results were also reported by Ikeda and Ibarki (1998) and Wang *et al*, (2001).

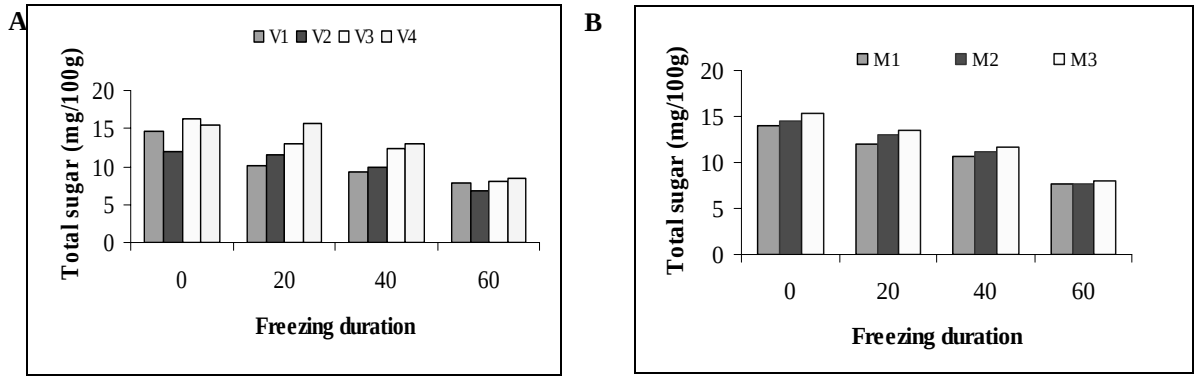

Figure 1. Change in total sugar of frozen bush bean (A) Genotypes and (B) Pod age stages (blanched at 50^0C for 5 min)

Percent retention of ascorbic acid varied from 5.41-40.08% among genotypes due to 5 min blanching. All the nutrients were higher in 20 days pods except ascorbic acid. Maximum (40.08%) ascorbic acid retention was observed from V_2. the loss was highest (94.59%) in V_1 at 60 days after freezing. Percent retention of protein varied from 70.29-97.72 among genotypes after freezing. The highest percent retention was found in V_3 genotype at 20 days after freezing for 5min blanching. The maximum amount of dry matter retention was observed from V_1 at 20 days after freezing for 5 min blanching. The highest sugar retention was observed in the genotype V_4 at 20 days pod age stage.

REFERENCE

Anonymous, 1991. Food consumption tables use in East Asia. FAO of the UN. Food Policy and Nutrition Division.

Brammer, H. 1971. Soil Resources. Soil Survey Project Bangladesh. AGL: SF/Pak, 6. Technical Report 3.

Evans, A. M. 1976. Generic improvement of *Phaseolus vulgaris*. In: Nutritional Improvement of Food Legumes by Breeding. Pp107-150. Milner, Max (Ed.). John Wiley and Sons, New York.

George, R. A. T. 1985. Vegetable Seed Production. Longman, London and New York. Pp. 193-207.

Ikeda, H. and T. Ibaraki. 1998. Effects of atmosphere composition on respiration rates, chemical components and keeping quality of broccoli. Bulletin of the Fukuoka Agricultural Research Centre 17: 102-105.

Lisiewaska, Z. and W. Kmiecik. 2000. Effect of storage period and temperature on the chemical composition and organoleptic quality of frozen tomato cubes. Food Chemistry 70: 167-173.

Mazumdar, S. N., 2003-04. Unnato Padhatita Jhar Sheamer Chaash (folder). BARI Pub. No. fldr 05/ 2003-04.

Petersen, M. A. 1993. Influence of sous vide processing, steaming and boiling in vitamin retention and sensory quality of broccoli florets. Zeitschrift for Lebensmittel-Untersuchung Und- Forschung. 197: 375-380.

Pleshkov, B. P. 1976. Practical works in plant biochemistry. Moscow, Kolos, pp. 236-238

Pogson, B. J. and S. C. Morris. 1997. Consequences of cool storage of broccoli on physiological and biochemical change and subsequent senescence at 200C storage. American Society for Horticultural Science 122 (4): 553-558.

Rekhi, S. S. 1997. Vegetable improvement and seed production. Paper presented in the National seminar on vegetable improvement and seed production held at BARI during March 3-4, Gazipur, Bangladesh.

Saheed, S. M. 1984. Soils of Bangladesh: General soil types. Soil Resources Development Institute (SRDI), Dhaka, Bangladesh. p. 3.

Shanmugacelue, K. G. 1989. Production technology of vegetable crops. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, pp. 446-461.

Somogyi, J. M. 1952. Notes on sugar determination. J. Biol. Chem. 195: 19-23

Wang, Z. P., Y. M. Lie and Z. Y. Fang. 2001. The changes in sugar, vitamin C and protein content in broccoli during storage. China vegetables 2: 27-29.