J. Bangladesh Agril. Univ. 6(2): 391–400, 2008 ISSN 1810-3030

Effect of storage conditions on quality and shelf life of selected winter vegetables

M.N.H. Jany, C. Sarker, M.A.R. Mazumder and M.F.H. Shikder
Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

Cabbage, cauliflower, country bean, tomato and pea were stored in room temperature for 8 days, at refrigerated (4^oC) temperature for 12 days and at freezing temperature (-18^oC) for 90 days. The vegetables were analyzed at every 2 days of storage period in room temperature, at the interval of 15 days at freezing and 3 days interval for refrigerated condition. Color, flavor, texture was better in freezing condition compared to the other conditions. The pH values after stored at room temperature 4.2, 4.32, 4.1, 3.33, 3.3, in refrigerated condition (without blanching) 4.83, 5.23, 3.33, 3.97, 4.37 and in refrigerated condition (with blanching) 3.27, 3.89, 3.98, 3.39, 4.77 and in freezing condition 5.47, 5.77, 4.76, 3.99 and 5.39 respectively. Vitamin C content of cabbage, cauliflower, country bean, tomato and pea after 8 days of storage at room temperature was 21.3 mg/100 g, 25.3 mg/100 g, 4.34 mg/100 g, 13.2 mg/100 g and 3.9 mg/100 g respectively. In refrigeration temperature (without blanching) after 12 days the values were 16.3 mg/100 g, 37.3 mg/100 g, 2.7 mg/100 g, 13.3 mg/100 g and 8.3 mg/100 g for cabbage, cauliflower, country bean, tomato and pea correspondingly. On the other hand in refrigeration condition (with blanching) vitamin C content of cabbage, cauliflower, country bean, tomato and pea were 3.3 mg/100 g, 18.3 mg/100 g, 2.4 mg/100 g, 2.9 mg/100 g and 9.3 mg/100 g in that order. Vitamin C content of cabbage, cauliflower, country bean, tomato and pea in freezing condition after 90 days of storage period were found 22.1 mg/100 g, 43.23 mg/100 g, 14.2 mg/100 g, 20.7 mg/100 g and 12.1 mg/100 g. The rate of weight loss increased with time progress of the storage period in all conditions.

Keywords: Ambient temperature, Refrigeration, Freezing, Blanching, Cabbage, Cauliflower, Tomato, Country bean and Peas

Introduction

Vegetables with increasing recognition of their value in the human diet, are gaining commercial importance. The nutritional value of vegetables as a vital source of minerals, vitamins, dietary fiber and fair amount of carbohydrate, protein and energy is known world wide. The present production of vegetable in Bangladesh is around one million tons per year, 70% of which is grown during winter season (Parveen, 2004). As a result, there is an acute shortage of vegetables for long time, which leads to chronic malnutrition among the people of Bangladesh. The post harvest losses of vegetables in Bangladesh could be as high as 43% (Sharma, 1987). However, the average post harvest loss is estimated to be 26% (Khan, 1991). It is estimated that as much as 25% of some vegetables are wasted during pick period. High perishability of vegetables, lack of storage facilities, mechanical injuries due to improper handling, packaging, transportation and microbial infection are the major causes of post-harvest losses in vegetables. According to a report of the National Academy of Science, Washington, DC (Anonymou**s**, 1978) the post-harvest losses of perishable commodities like vegetables might be 80-100% in some instances. With a loss of about 10 - 15% in fresh weight, vegetables shriveled and reach a state of low market value and consumer acceptability.

Cabbage, cauliflower, tomato, country bean and peas are the popular winter vegetables in our country and play an important role to meet the vegetables shortage during the scarce period. The present traditional methods of harvesting, handling, packaging and storing of

vegetables can be improved with a little additional coast or interference with the existing marketing practices. Expensive machinery is not always required; more efficient and better utilizations of the existing facilities are often sufficient. Improvement in the shelf-life of vegetable is an utmost need to reduce the post-harvest losses. The post-harvest losses include significant qualitative, quantitative and economic losses. The post-harvest losses of vegetables can be minimized by prolonging the shelf-life of vegetables (Talukder, 2002). The objectives of this study are: i) to assess the pattern of changes in physical and chemical parameters of the selected vegetables during storage, ii) to extend the shelf-life without affecting the quality and iii) to assess the storability of different vegetables under various conditions.

Materials and Methods

The experiment was conducted at the laboratories of Food Technology & Rural Industries, Bangladesh Agricultural University, Mymensingh. Cabbage cv. BARI Badakopi-1 (Provati) collected in the morning of December 10, 2007. Cauliflower cv. BARI Cauliflower-1 (Rupa) collected in the morning of December 8, 2007. Tomatoes cv. Marglob was harvested in the morning of February 10, 2008. Soft and edible pods of country bean were harvested in the morning of January 25, 2008 and peas were collected from KR market. The maximum and minimum room temperatures during storage period were 24^0C and 15^0C respectively and relative humidity 64 to 94%.The well graded selected vegetables were washed thoroughly using clean and safe water to remove foreign matter and dust. Vegetables were first washed, drained, sorted, trimmed, and cut as for cooking fresh. One gallon of water was used per pound of prepared vegetables. Vegetables were put into blancher (wire basket, coarse mesh bag, or perforated metal strainer) and lowered into boiling water for 5 min at 85- 90^o C. A lid was placed on the blancher and started counting blanching time immediately and cooled immediately in cold water for the same time used in blanching. Vegetables were stirred several times during cooling and drained thoroughly.

Post harvest storage treatments

1. Wrapping with polythene bag and kept at the normal temperature.
2. Wrapping with polythene bag and stored in refrigerated (4^0C).
3. Blanched vegetables wrapping with polythene bag and kept in refrigerator.
4. Wrapping with polythene bag and frozen at -18^0C.

Analysis of vegetables

Organoleptic assessment: Color, flavor and texture were measured by visual inspection.

Shrinkage, freshness and changes of color: Visual observations on shrinkage, freshness and color changes were recorded. Weight loss was measured as a reduction in weight of the vegetables preserved. The weights of the vegetables preserved under different treatments were taken at an interval of three days.

Physico-chemical parameters: Vegetables from each treatment were selected at random at an interval of 2 days, such as 1 and 4 days for physico-chemical analysis. Chemical analysis was also performed during storage period. The physico-chemical parameters were estimated through the methods by Ranganna, 2003.

Chemical Analysis

pH was determined by the method described Covenin (1984). Vitamin C and Weight loss was determined by the method described Ranganna, 2003.

Results and Discussion

Cabbage stored in Low Quality Market Polythene (LQMP) at normal temperature remained good up to 6 days of storage. Off flavor and blackish color developed after 6 days of storage. After 8 days, it becomes dark black. In case of refrigeration cabbage remains edible upto 8 days. But when cabbage are blanched and stored in refrigerator, off flavor and gummy materials were obtained after 8 days of storage. In case of freezing condition the cabbage remains edible up to 90 days.

Cauliflower stored in LQMP at normal temperature remained edible up to 6 days of storage. Normally, the curds of cauliflower were firm and whitish, stalks remained green and attached to the curd, and physical appearance was comparatively better. After 6 days of storage the cauliflower curds and stalks started rotting and ultimately became unsuitable for consumption. In case of refrigeration, the cauliflower curds and stalks started rotting and ultimately became unsuitable for consumption after 12 days of storage. In case of refrigerated blanched sample, the cauliflower curds and stalks became unsuitable for consumption after 9 days of storage. But in case of freezing the curds and stalk of cauliflower was suitable for consumption upto 90 days.

Country bean stored in LQMP remained edible up to 9 days. After 9 days shrinkage and brownish spot developed and became inedible after 12 days. In case of refrigeration the country beans were in partially shrinkage upto 12 days of storage. But when country bean were blanched and stored in refrigerator, remains edible up to 8 days. After 9 days gummy materials and off flavor developed and unsuitable for consumption. In case of freezing the quality of country bean remains good up to 90 days.

Tomato stored in LQMP remained edible and marketable up to 10 days of storage. The tomatoes were in red color and firm and the physical appearance was comparatively better at initial stage. But after 9 days, the tomato starts to shrinkage and unsuitable for consumption after 12 days of storage. But when tomatoes were blanched and stored in refrigerator, remain better up to 8 days storage. After 9 days off flavor and gummy materials developed and became unsuitable for consumption. During freezing tomato remains suitable for consumption up to 90 days.

Pea used in this experiment was greenish and firm and the physical appearance was better. But, 9 days of storage the pea stored in normal temperature develops black spot and shrinkage. After 12 days it becomes dark black. In case of refrigeration peas remain edible after 12 days of storage. In case of blanched and refrigeration, peas remain edible up to 6 days. After 6 days gummy substances with off flavor develops and unsuitable for consumption. In case of freezing condition the peas remain better up to 90 days.

Shelf life studies of selected vegetables stored at room temperature

For cabbage color, flavor and texture changed to blackish, spoiled and very soft respectively after 9 days of storage. But for cauliflower color, flavor and texture changed to black spot, spoiled and rotten curd respectively after 9 days of storage. In case of country bean color, flavor and texture changed to black spot, spoiled and soft respectively after 9 days of storage. For tomato no change in flavor, color became deep red and little bit shrinkage of texture after 9 days of storage. But incase of peas color, flavor and texture changed to blackish, spoiled and shrinkage respectively after 9 days of storage.

Shelf life studies of selected vegetables at refrigeration (without blanching) storage (4 ^{0}C)

Color, flavor and texture changed to black, spoiled and very soft respectively after 12 days storage of cabbage. But in case of cauliflower color, flavor and texture changed to blackish, spoiled and firm curd respectively after 12 days of storage. No change in color, flavor and but texture changed to soft in case of country bean after 12 days of storage. For tomato no change in flavor, color became deep red and firm texture after 12 days of storage. But incase of peas color, flavor and texture changed to blackish, spoiled and sprouted respectively after 12 days of storage.

Shelf life studies of selected vegetables at refrigeration (with blanching) storage (4 ^{0}C)

Color, flavor and texture changed to black, spoiled and gummy respectively after 12 days storage of cabbage. But in case of cauliflower color, flavor and texture changed to black spot, spoiled and gummy respectively after 12 days of storage. In case of country bean color, flavor and texture changed to black spot, spoiled and gummy respectively after 12 days of storage. For tomato no change in flavor, color became deep red and gummy texture after 12 days of storage. But incase of peas color, flavor and texture changed to blackish, spoiled and gummy respectively after 12 days of storage.

Shelf life studies of selected vegetables at freezing storage (-18 ^{0}C)

Cabbage, cauliflower, country bean, tomato and peas were acceptable upto 90 days of storage because no change in color, flavor and texture observed upto 90 days.

Loss of nutrient in selected vegetables

The variation in vitamin C content among the vegetables was highly significant. It was observed that vitamin C content was the highest in cauliflower among the vegetables. The vitamin C contents (mg/100g) of cauliflower were 48.4, 45.75, 29.04 and 25.3 at initial, 3rd, 6th and 9th days of storage, respectively. The lowest vitamin C was in pea 15.84, 5.72, 4.4 and 3.9 at initial, 3rd, 6th and 9th days of storage respectively. It was also noticed that the mean values of vitamin C reduced drastically in all vegetables during storage. The interaction effects of postharvest storage treatments and vegetable species on vitamin C content significant at 30th, 60th and 90th day of storage. The highest vitamin C content was 43.23 mg/100 g was recorded in cauliflower. When stored at freezing temperature and the lowest 12.1 mg/100 g was recorded in pea after 90 days of storage. The results of the present investigation have got support of Nazar *et al.* (1996) and Eris *et al.* (1994) and Pal *et al.* (2002). They reported that vitamin C content decreased gradually during storage and transport. The decrease in vitamin C content with storage duration was attributed to the oxidation of ascorbic acid into dehydro-ascorbic acid by the enzyme ascorbic acid oxidase. In the present study, the vegetables is in freezing condition exhibited higher vitamin C content during the later period of storage and this phenomenon could be explained by the oxidation process negatively correlated with supply of oxygen (O_2).

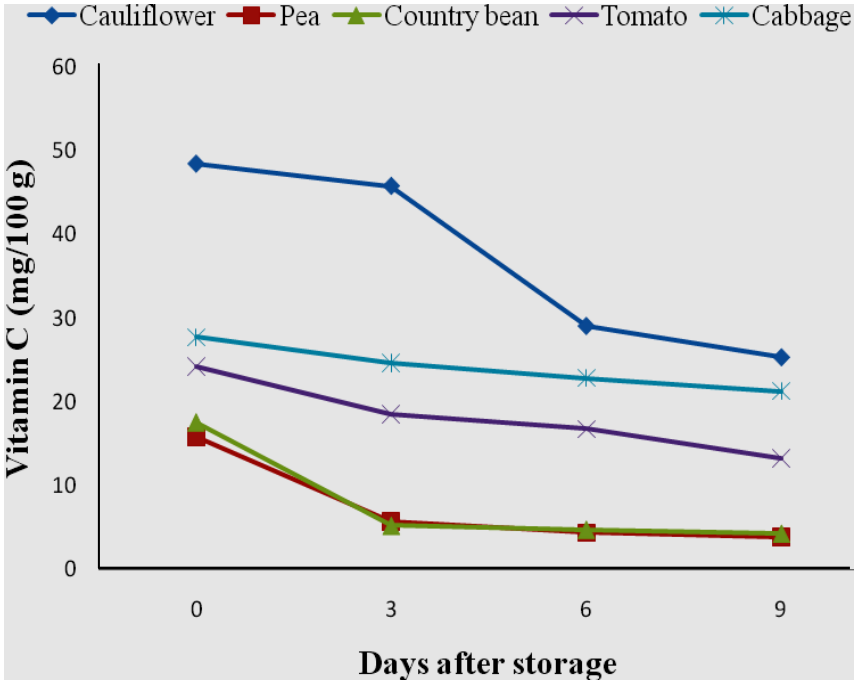


Fig.1. Effect of ambient temperature on vitamin C content

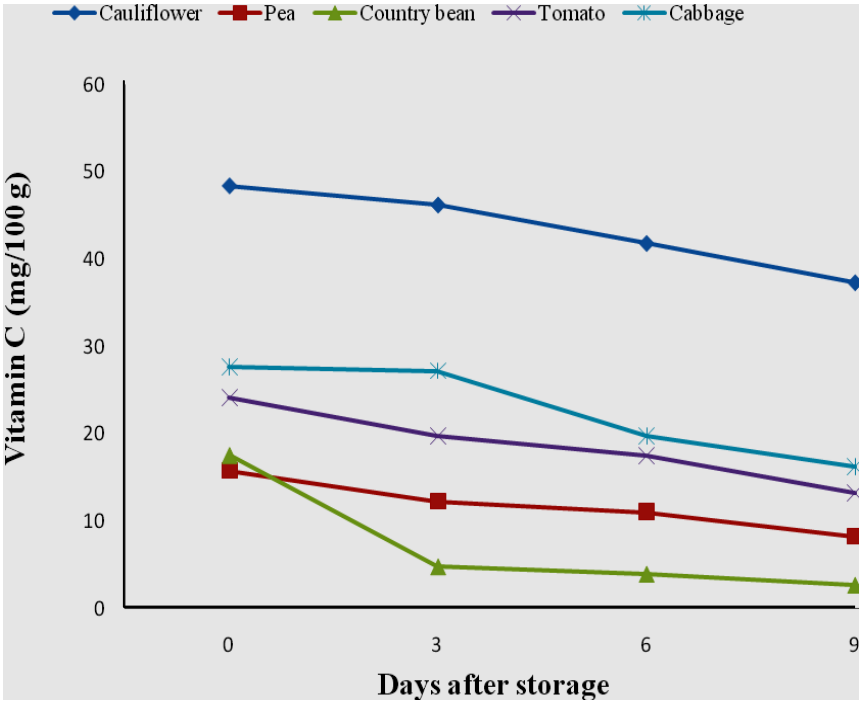


Fig.2. Effect of refrigeration (without blanching)

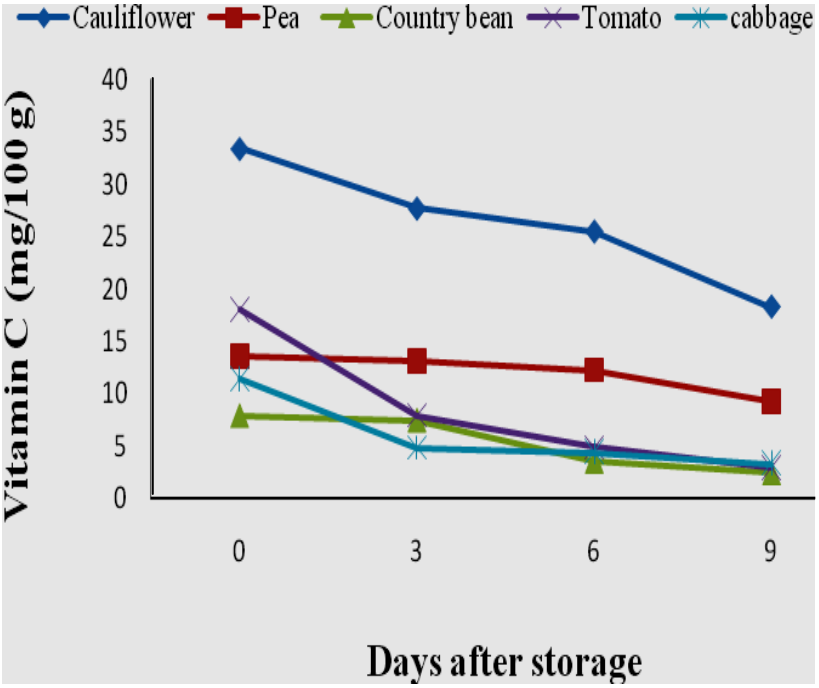


Fig. 3. Effect of refrigeration (with blanching) on vitamin C content

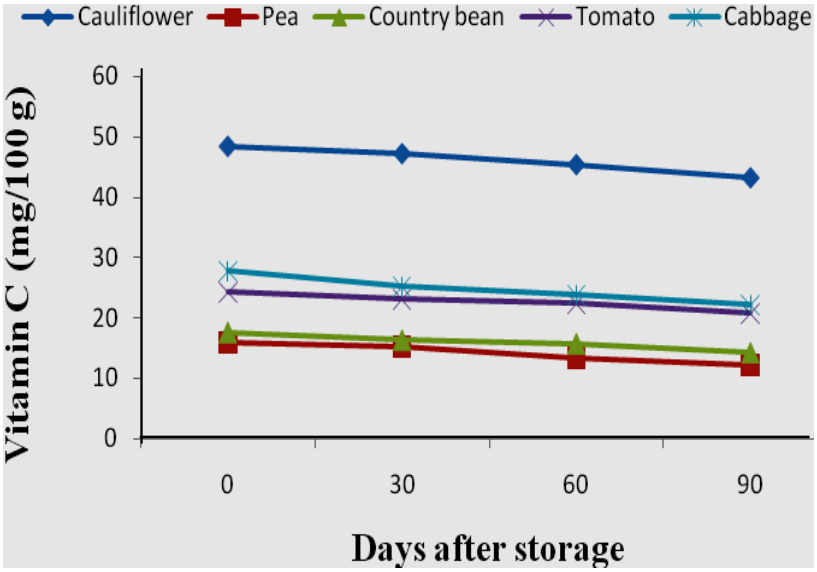


Fig. 4. Effect of freezing on vitamin C content

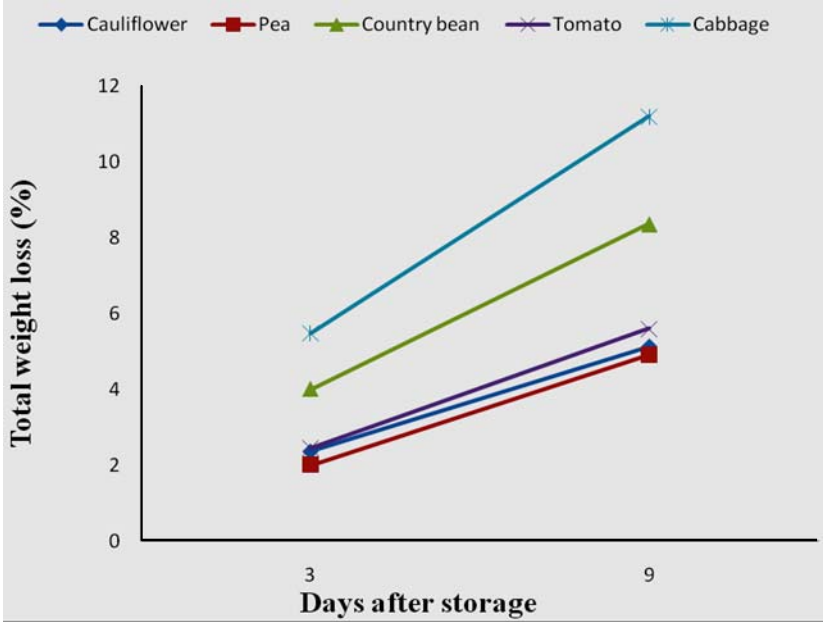


Fig.5. Effect of ambient temperature on total weight loss

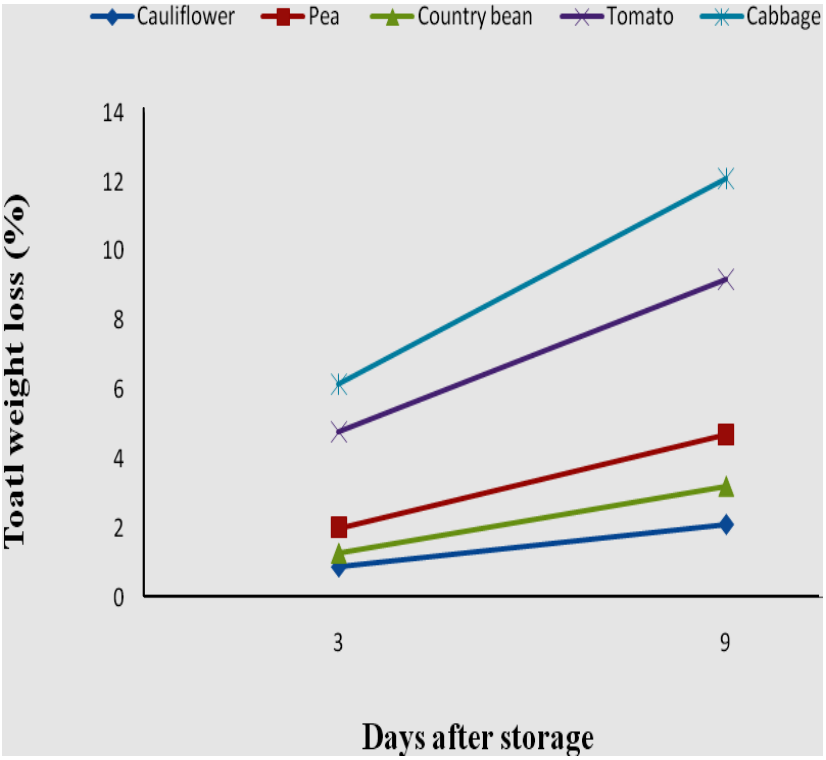


Fig.6. Effect of refrigeration (with blanching) on total weight loss

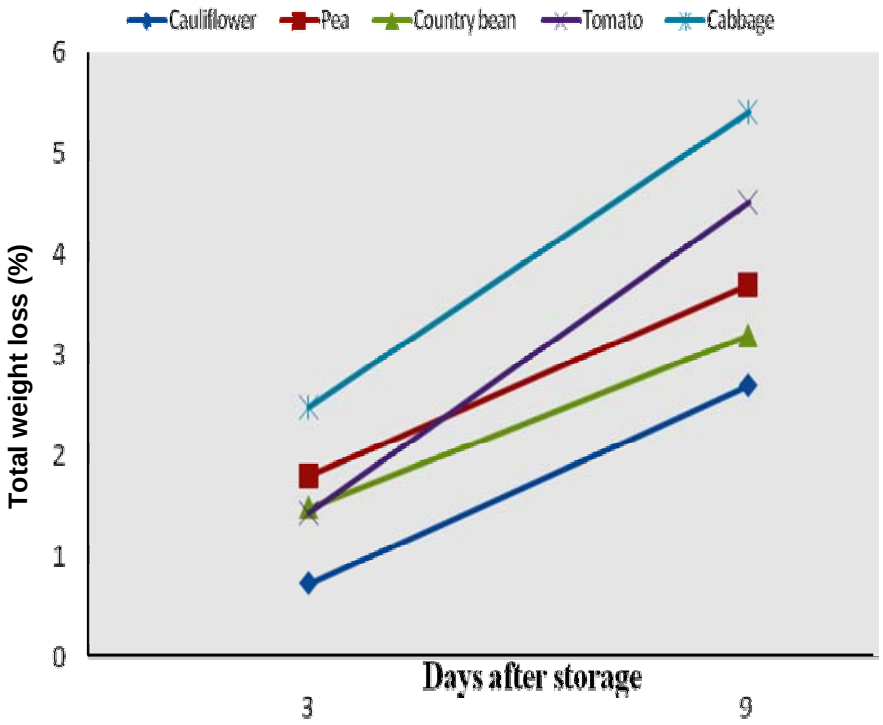


Fig.7. Effect of refrigeration (without blanching) on total weight loss

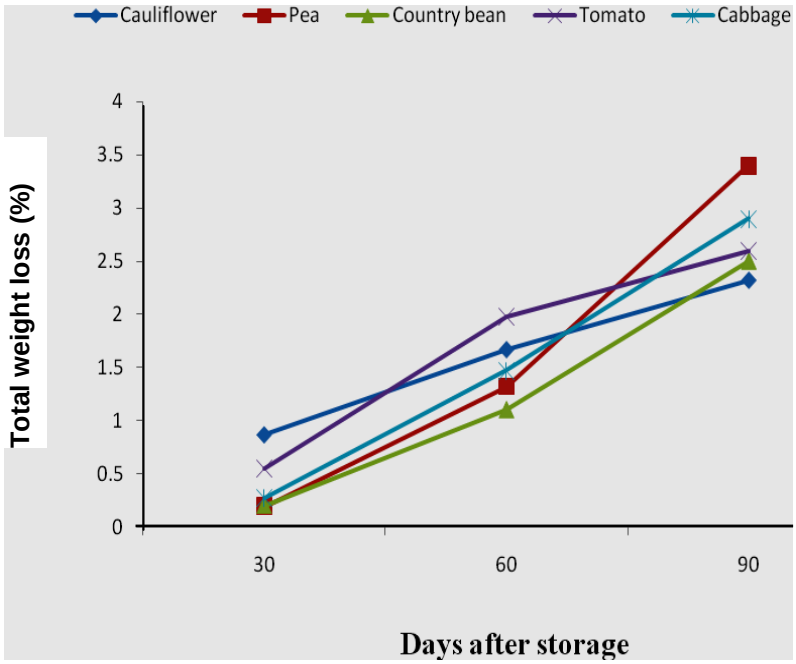
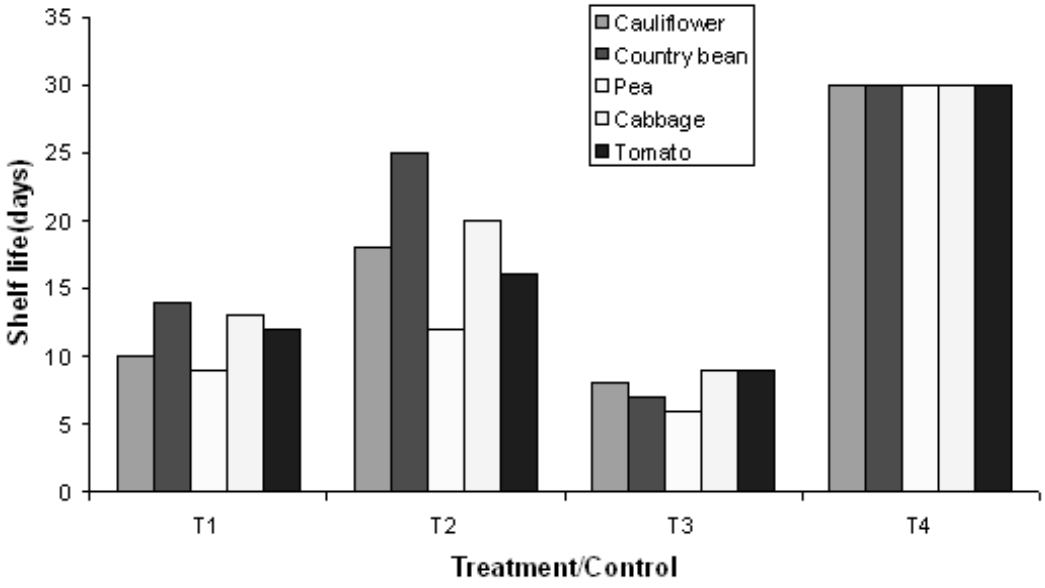


Fig. 8 Effect of freezing on total weight loss

Shelf life of stored vegetables

In the present investigation significant variation was observed for the shelf life of vegetable species. At normal temperature the shelf life of cauliflower was 10 days, country bean 14 days, pea 8 days, cabbage 12 days and tomato 12 days. In case of refrigeration, the shelf life of cauliflower was 18 days, country bean 25 days, pea 12 days, cabbage 20 days and tomato 15 days. In case of refrigerated blanched condition, the shelf life of cauliflower was 8 days, country bean 7 days, pea 6 days, cabbage 10 days and tomato 10 days. In case of freezing condition, the shelf life of cauliflower was 30 days, country bean 30 days, pea 30 days, cabbage 30 days and tomato 30 days. The maximum shelf life was observed in freezing condition followed by 30 days whereas the minimum shelf life (6) was recorded in case of refrigerated blanching condition of pea.



T_1 = Normal temperature, T_2 = Refrigeration, T_3 = Refrigeration with blanching and T_4 = Freezing

Fig. 9. Combined effects of treatments on shelf life of different selective winter vegetables

Storage in freezing increased shelf life of vegetables in the present study and this result was in agreement with the findings of Padmanaban *et al.* (1994). In another experiment, Pantastico *et al.* (1975) extended the storage life of vegetables by keeping them at 10 to 11.7^{0}C with 92% relative humidity. The increase in shelf life was probably due to the reduction of various gaseous (O_2, CO_2) exchange from inner and outer atmosphere as well as slowing down the process leading to ripening by different postharvest treatments.

Conclusion

It was found that quality of vegetables which stored in freezing conditions remained better after 3 months of storage. From the experiment we find that shelf life of different vegetables were comparatively better in freezing conditions.

References

Anonymous. 1978. Analysis of a FAO survey of post-harvest crop losses in developing countries. Food and Agriculture Organization of the United Nations, Rome, Italy. pp. 120-123.

Covenin, N. 1984. Determination of del pH (acidizlonica) an elements. 1315: 75.

Eris, A., Ozgur, M., Ozer, M., Copur, M.H. and Henze, J. 1994. A research on controlled atmosphere (CA) storage of lettuce. Acta. Hort., 368: 786-792.

Khan, A.R. 1991. Crop loss and waste assessment, Consultant's Report, USAID/BARC/ AHECCE & Co. Inc. Dhaka. p. 112.

Nazar, M., Jamil, M., Anwar, M. and Ehtashamuddin, A. F. M. 1996. Film packaging of fresh vegetables. Sarhad J. Agric. 12 (2): 185-192.

Padmanaban, G. Nagarajan, M., Mania, K. and Annamalainthan, K. 1994. Postharvest of vegetables using fused calcium salts. Madras Agric. J. 81(8): 460-461.

Pal, U.S., Sahoo, G.R., Khan, M.K. and Sahoo, N.R. 2002. Post harvest losses in tamato, cabbage, cauliflower. Agril. Mech. in Asia, Africa & Latin America. Vol. 33. pp. 34-40.

Parveen, S. 2004. Effects of Post Harvest Treatments on Shelf-life and Quality of Some vegetables. MS Thesis. Submitted to the Depertment of Horticulture. p.1.

Pantastico, Er. B. Chattopadhy, T.K. and Subranmanyam, H. 1975. Postharvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables. Ed. Er. B Pantastico, AVI Publishing Co. Westport, USA. p. 474

Ranganna, S. 2003. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Edition. pp. 12-26.

Sharma, S.K. 1987. Training Manual of Vegetables and Social Forestry. Department of Agricultural Extension. MOA/FAO/UNDP (Project BGD/79/034), Dhaka, Bangladesh. p. 167.

Talukder, S. 2002. Prepackaging, storage losses and physiological changes of some fresh vegetables by post harvest treatments. MS Thesis. Department of Food Technology and Rural Industries. pp. 1-3.