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EFFECT OF SHORT TERM STORAGE AND PACKAGING TECHNIQUE ON QUALITY OF HYACINTH BEAN IN ZERO ENERGY COOL CHAMBER

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Abstract

The effect of short term storage of fresh hyacinth bean in zero energy cool chamber (ZECC) before marketing was evaluated. The marketable life of bean could be extended eight days more by reducing temperature from 8 to 6°C and increasing relative humidity from 30 to 33%. This storage conditions will maintain freshness, color retention (8.65%), low physiological loss in weight (3.15%), reduce decay loss (3.78%), retain nutrients like β-carotene (12.63 µg/g) and ascorbic acid content (18.54 mg/100 g) using perforated plastic crate with cushioning material as compared to ambient condition.

Introduction

Hyacinth bean (*Lablab purpureces* L.) is an important vegetable, which contains more nutrition specially vitamins and minerals. Due to its perishability, physiological changes and lack of proper postharvest technologies, every year a huge postharvest loss occurred. Worldwide the losses are as high as 30 to 40% (Bhattarai *et al*. 2013) where in Bangladesh, it is calculated as 23.6-43.5% (Hasan *et al.* 2010) with individual loss of bean 28.62% (Molla *et al.* 2011).

Temperature, relative humidity and good package could extend the shelf life of the products (Choudhury 2005) and it can be maintained by refrigerator. But refrigeration involves mechanical components and electricity which is the main barrier in some developing countries especially for Bangladesh due to its erratic power supply, unavoidable situations under the prevailing of socio-economic conditions of the people. Therefore, low cost environment friendly zero energy cool chamber (ZECC) may be alternative way for short term storage of hyacinth bean (Singh and Satapathy 2006, Dadhich *et al.* 2008).

Materials and Methods

Fresh horticultural matured hyacinth bean (local variety) was directly harvested from the farmers' field at physiological age of 30 - 35 days from fruit setting. Then the bean was sorted, graded, treated (Table 1) and stored in ZECC. The ZECC was made with a single layer of floor and double layer of walls using first class brick. The space between the walls filled with river bed sand where the thickness between the walls was 7.5cm, height 67.5cm and length 118cm.

PLW (%) was determined by the formula of PLW (%) = $\frac{W_0 - W}{W_0} \times 100$

where PLW= Physiological loss in weight, W_0 = Initial weight and W = Final weight.

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Decay loss (%) was determined by the formula of $DL\ (\%) = \frac{W_0}{W_0} \times 100$

where DL = Per cent decay loss, W_0 = Weight of decayed beans and W = Weight of stored bean

Color retention (%) was determined by visual observation through formatting a judge panel (10 judges, Table 2).

Table 1. Combined treatment of hyacinth bean.

Treatment combinations	Details
$A_0B_0C_0$	Outside ZECC and kept in without packaging and cushioning material
$A_1B_0C_0$	Inside ZECC and kept in without packaging and cushioning material
$A_1B_1C_0$	Inside ZECC and kept in bamboo basket without cushioning material
$A_1B_2C_0$	Inside ZECC and kept in plastic crate without cushioning material
$A_1B_0C_1$	Inside ZECC and kept in without packaging with cushioning material
$A_1B_1C_1$	Inside ZECC and kept in bamboo basket with cushioning material
$A_1B_2C_1$	Inside ZECC and kept in plastic crate with cushioning material

Table 2. Color and score of hyacinth bean.

Color	Score (0 - 10)
Fully green, shiny and attractive	4 - 10
Light yellow green	2 - 4
Yellow green with spot	Below 2

Ascorbic acid (Ranganna 1991) and β-carotene content (Negi and Roy 2004, methods of vitamin assay 1966) were determined. The marketable life of the bean was subjectively assessed (Islam *et al.* 2015, Table 3). Temperature and relative humidity were recorded using digital thermo- and hygrometer (VC230A, China).

Table 3. Marketable life and score of hyacinth bean.

Score (0 - 100)	Marketing status	Comments
90 - 100	Fresh with fully green as like as harvest, marketable with high price	Excellent
80 - 90	Fresh but light yellow green, marketable and cheaper	Good
Below 80	Yellow green, shrinkage with spot, nobody will buy it (although it is cheap)	Not acceptable

MSTAT-C (ANOVA) was performed for means separation of data and SPSS (17.0) was used for correlation analysis of nutritional value.

Results and Discussion

Temperature and relative humidity in inside and outside of the ZECC: In inside of the ZECC, the temperature was unchanged both morning and evening except noon. The ZECC reduced the temperature from 8 to 6^{o}C and increased the relative humidity from 30 to 33% as compared to the ambient condition (Figs 1 and 2). The lower temperature and higher humidity may be attributed due to wetting of the jute sacks and the evaporation of water in the sand that contributed to reduce the temperature and higher the relative humidity (Roy and Khurdiya 1986, Meena *et al.* 2005, Singh and Satapathy 2006).

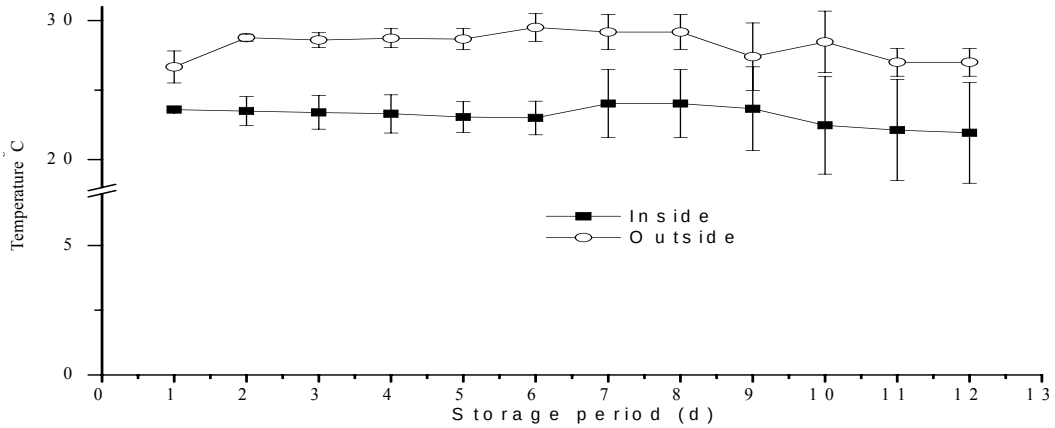

Fig.1. Relationship between inside and outside temperature (^{0}C) of ZECC.

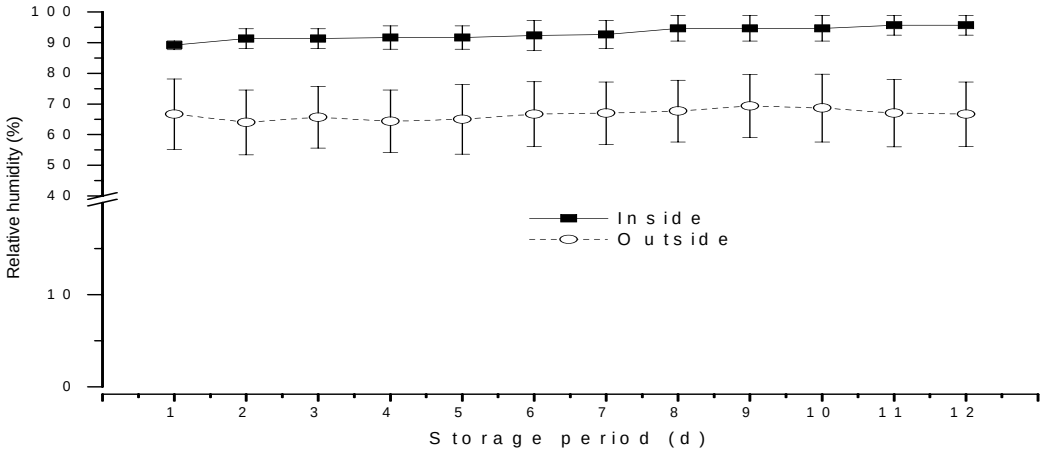

Fig. 2. Relationship between inside and outside relative humidity (%) of ZECC.

During 3 days of storage, there was no PLW for both inside and outside of the ZECC but after this period, the PLW started and recorded 6.79 and 2.12% in outside and inside of the ZECC, respectively (Table 4). After 12 days of storage, the maximum PLW was recorded 21.52% in outside the ZECC whereas it was only 3.150% in inside (Islam and TO 2012). In terms of storage periods, the bean kept in outside of the ZECC as open condition and bamboo basket under both cushioning techniques (and without with) was insignificant whereas in other conditions the results

statistically differed. However, the PLW was significant between outside and inside of the ZECC and the lower PLW in inside may be because of its lower transpiration rate.

Up to 3 days of storage, no loss due to decay was found both inside and outside of the ZECC (Table 5). From 6 days of storage, the loss was recorded 10.42% in outside while it was 2.88% in inside of the ZECC. After 12 days of storage, 15.14% loss was recorded in outside whereas it was 3.78% only in perforated plastic crate with cushioning material in inside. However, in terms of storage periods, statistically there were insignificant relationship but the bean stored in bamboo basket with and without cushioning technique in outside and in inside were significant (Table 5). This may be because of lower temperature and evaporation nature of the ZECC (Narayana *et al.* 2006).

Table 4. Percentage of PLW of hyacinth bean under different storage periods.

Interaction effect	Storage periods (days)			
	3	6	9	12
$A_0B_0C_0$	6.79a	10.89a	19.41a	21.52a
$A_0B_1C_0$	5.68b	8.38b	11.36b	14.55b
$A_0B_2C_0$	3.72e	6.17d	9.37d	11.91c
$A_0B_0C_1$	4.65c	6.63c	9.72c	11.93c
$A_0B_1C_1$	4.12d	6.13d	8.09e	10.12d
$A_0B_2C_1$	3.06f	5.05e	6.08f	8.14e
$A_1B_0C_0$	2.12g	3.10f	4.58g	4.97f
$A_1B_1C_0$	2.15g	3.04f	4.50g	4.91f
$A_1B_2C_0$	1.94h	2.68g	3.15h	4.25h
$A_1B_0C_1$	1.83h	2.06h	3.41h	4.79g
$A_1B_1C_1$	1.68h	1.79h	2.81i	4.61g
$A_1B_2C_1$	1.05h	1.38h	2.55i	3.15i

Table 5. Percentage of decay loss and color retention of hyacinth bean under different storage periods.

Interaction effect	Storage periods (days)					
	6		9		12	
	Decay loss (%)	Color retention (%)	Decay loss (%)	Color retention (%)	Decay loss (%)	Color retention (%)
$A_0B_0C_0$	10.42a	3.51k	12.24a	2.37k	15.14a	1.30j
$A_0B_1C_0$	10.29b	3.61j	11.29b	2.80h	13.71b	1.43i
$A_0B_2C_0$	10.12b	4.11h	11.16b	3.33g	13.60b	2.63f
$A_0B_0C_1$	6.81c	3.25l	9.11c	2.69i	11.23c	1.62h
$A_0B_1C_1$	6.34d	3.94i	9.13c	2.54i	11.19c	1.71g
$A_0B_2C_1$	6.47d	4.59g	8.74d	3.35g	10.06d	2.64f
$A_1B_0C_0$	2.88e	5.13f	3.72e	4.90f	4.96e	4.39e
$A_1B_1C_0$	2.49f	6.19d	3.54e	5.11e	4.56f	5.30d
$A_1B_2C_0$	1.27i	7.71b	2.42g	6.15c	4.32g	5.78c
$A_1B_0C_1$	1.94g	5.64e	2.63f	5.49d	4.18	5.25d
$A_1B_1C_1$	1.52h	7.59c	2.47g	7.31b	4.23g	6.70b
$A_1B_2C_1$	1.17i	8.91a	2.38g	8.74a	3.78h	8.65a

Table 5 shows that no color change during 3 days of storage but the change was initiated from 6 days of storage in both storage conditions. After 12 days of storage, the bean stored in inside of the ZECC for all cases like open condition, bamboo basket and perforated plastic crate obtained

score from 4.39 to 8.65% while from 1.30 to 2.64% score was obtained by outside of the ZECC. In terms of storage periods, the color remained statistically unchanged into plastic crate with cushioning technique in inside of the ZECC. The color retention in inside of the ZECC might be attributed to reduce rate of respiration and transpiration of bean due to relatively low temperature and high relative humidity.

Table 6. Ascorbic acid (mg/100 g) and β-carotene (µg/g) content of hyacinth bean under different storage periods.

Interaction effect	Storage periods (days)							
	3		6		9		12	
	Ascorbic acid	β-carotene	Ascorbic acid	β-carotene	Ascorbic acid	β-carotene	Ascorbic acid	β-carotene
$A_0B_0C_0$	8.13k	9.22j	6.13i	8.33j	5.15j	7.44j	4.07k	5.40g
$A_0B_1C_0$	9.26i	10.26h	8.67g	9.20h	7.28h	7.60h	5.34i	6.18f
$A_0B_2C_0$	11.29g	11.29g	10.02f	10.02d	8.21g	8.21g	6.98g	6.99e
$A_0B_0C_1$	8.74j	9.74i	7.13h	8.13j	6.15i	7.15i	4.78j	5.07h
$A_0B_1C_1$	10.26h	10.26h	9.00g	9.00i	7.28h	7.28i	6.34h	6.34f
$A_0B_2C_1$	12.44e	11.44d	10.01f	9.35h	9.54f	8.54f	8.12f	7.12e
$A_1B_0C_0$	14.49e	13.67f	13.19e	11.20f	12.19e	9.23e	10.25e	8.18d
$A_1B_1C_0$	16.31d	13.83e	15.12d	12.24d	14.26d	10.11d	12.13d	8.09d
$A_1B_2C_0$	18.44c	16.08b	17.21c	13.87b	16.21c	12.13b	14.23c	10.13b
$A_1B_0C_1$	16.44d	14.83d	15.21d	11.65e	14.29d	10.13d	12.29d	9.11c
$A_1B_1C_1$	20.36b	15.15c	19.42b	13.23c	17.39b	11.19c	15.26b	10.14b
$A_1B_2C_1$	22.38a	17.29a	21.59a	15.34a	20.45a	13.34a	18.54a	12.63a

After 3 and 12 days of storage, the ascorbic acid content was 22.38 and 18.54 mg/100 g in perforated plastic crate in inside of the ZECC whereas it was only 8.13 and 4.070 mg/100 g in open outside condition (Table 6). The results indicate that the ascorbic acid content of the hyacinth bean gradually decreased with the increase of storage periods under both storage conditions and different kinds of packaging techniques (Brar *et al*. 2013, EI. Ashwah *et al.* 1980, Molla *et al.* 2007). In inside of the ZECC, ascorbic acid content under different packaging and cushioning techniques did not statistically differ in terms of storage periods but individually there was significant relationship among them (Table 6).

β-carotene content statistically differed between inside and outside of the ZECC and among different packaging techniques (Table 6). After 3 and 12 days of storage, the ranges of β-carotene was 13.67-17.29 and 8.18-12.63 µg/g in inside of the ZECC without packaging and cushioning material whereas it was 9.22-11.44 and 5.40-7.12 µg/g at ambient condition (Table 6). In case of packaging and cushioning techniques, the *β*-carotene contents were 17.29 and 12.63 µg/g in inside of the ZECC while it was 9.22 and 5.40 µg/g in outside of the ZECC after 3 and 12 days of storage. The lower *β*-carotene content in outside of the ZECC may be attributed to unfavorable temperature and relative humidity (Negi and Roy 2004). In inside of the ZECC, although the data of plastic crate without cushioning and with cushioning techniques did not statistically differ in terms of storage periods but significant relationship was observed when compared with others (Table 6).

The ZECC achieved average score 96.5% where it was 61.4% which was not acceptable and considered as non-marketable according to the perception of the judgment (Fig. 3). It shows that the marketable life of hyacinth bean was maximum (11 days) in inside of the ZECC whereas it

was 3 days only in outside of the ZECC which indicates that the ZECC extended the marketable life 8 days (Roy and Khurdiya 1986, Dadhich *et al*. 2008, Rayaguru *et al.* 2010).

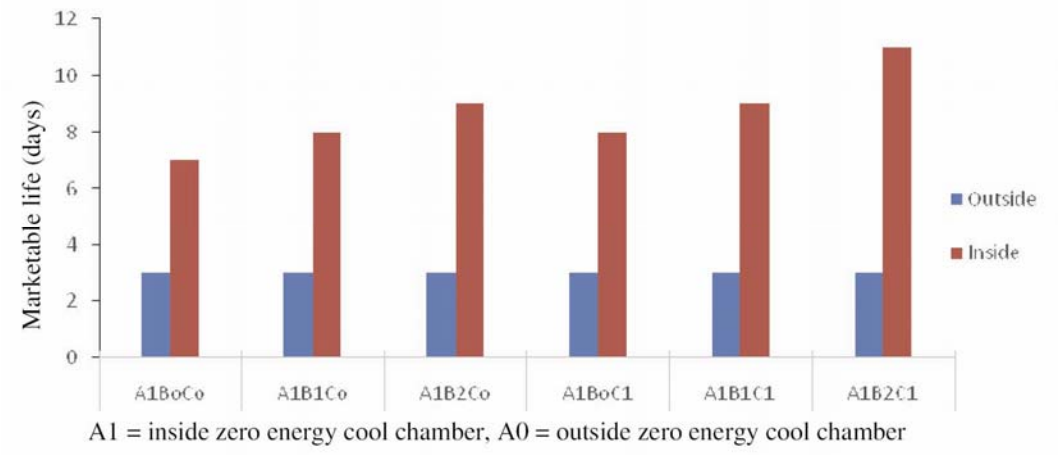

Fig. 3. Marketable life of hyacinth bean in inside and outside of the ZECC.

Table 7 shows that the value of *β*-carotene and ascorbic acid content had statistically significant relationship ($p \leq 0.01$) to PLW, color and decay ratio, which indicates that a highly correlation is observed between the nutritional value and physical characteristics (PLW, color and decay) of the hyacinth bean.

Table 7. Correlation analysis of nutritional value of hyacinth bean during storage.

Parameters	*β*-carotene	PLW	Ascorbic acid	Color	Decay
β-carotene	1	–0.961**	0.904**	0.941**	0.988**
PLW		1	–0.953**	–0.866**	–0.956**
Ascorbic acid			1	0.863**	–0.941**
Color				1	–0.941**
Decay					1

** indicates correlation is highly significant at $p \leq 0.01$ level.

Results suggest that it may be possible to extend marketable life of bean by eight more days with maintaining them at low temperature (6 to 8^{o}C), high relative humidity (30 to 33%) by perforated plastic crate with cushioning material in inside of the ZECC as compared to ambient condition. This storage method will also retain color (8.65%), low PLW (3.15%), reduce decay loss (3.78%), and preserve *β*-carotene (12.63µg/g) and ascorbic acid content (18.54mg/100g).

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