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EFFECT OF PACKAGING TECHNIQUES AND CHLORINATION ON THE QUALITY AND SHELF LIFE OF COUNTRY BEAN (*Lablab niger*)

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Abstract

The experiment was conducted to evaluate the effect of packaging materials on the quality and shelf life of country bean (*Lablab niger*) using passive modification of modified atmosphere packaging system. The modified atmosphere was created by making perforation in the packets made by polypropylene. Bean pre-treated with chlorine water and then packaging in selected polypropylene resulted substantial reduction in losses caused by weight loss and rotting/shriveling. These treatment combinations also considerably retained vitamin C, β -carotene, moisture content, etc. Under this condition, the retention of quality and shelf life of bean could be extended upto 8 days at ambient condition as compared to non-treated and without packaging.

Key Words : Packaging techniques, chlorination, shelf life, country bean.

Introduction

Country bean (*Lablab niger*) is one of the major fruit vegetables from the leguminosae family. In addition to the protein contributions of the legumes, these are also rich in other nutrients, such as starch, dietary fiber, protective phytochemicals, oil, vitamins and mineral elements (Saikia *et al.*, 1999). The total vegetable production in Bangladesh is about 72.78 lakh metric tons from 6.04 lakh hectares of land in 2004-2005 (DAE, 2006). A large quantity of these vegetables is lost due to lack of proper postharvest handling, transportation, packaging and storage facilities. The postharvest losses of vegetables in the developing countries lie between 20% and 50% and between 5% and 25% in the developed countries (Amiruzzaman, 2000). Since beans are highly perishable as other vegetables, these are also subject to huge losses during the peak production season mainly through transportation, storage and marketing.

In the super market, the shelf life of leafy/fruit vegetables has been found to be very short. The suppliers generally use gunny bags, big cartoons or boxes for carrying vegetables. The market authority stored the collected vegetables in different chambers in their cold room. They maintain the temperature at around 20 °C, but they do not maintain the humidity. As a result, the respiration rate is

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high and the vegetables to deteriorate quickly. The storage of vegetables in small packet with or without some pretreatments and controlling its humidity may extend the shelf life of the vegetables. Pretreatments of vegetables with potassium permanganate or chlorine water before packaging exhibit better shelf life in room temperature (Giraldo *et al.*, 1977). Again, the demand of the consumers is only one to two kilograms. However, there is no standard packet of such quantity. Standardization of packages will extend the shelf life of vegetables as well as reduce the postharvest losses.

Materials and Method

Fresh country beans (*Lablab niger*) were collected from the nearby producers. In the laboratory, the beans were sorted out to remove the anthracnose affected, over matured and damaged ones. The experiment was laid out in CRD factorial with 2 factors and three replications. The first factor was differently perforated packaging and the second factor was with chlorine (200ppm chlorox/halotab, 2 tablets per 1.5 litre water) water treatment. Each replication of the treatments consisted of 500g vegetables. Polypropylene was used as packaging material and the packages were modified with different perforations (0%, 0.5%, 1.0% and 1.5% perforation) to restrict the respiration of the beans. Respiration involves the oxidative breakdown of complex substrate molecules, normally present in plant cells, such as starch, sugars and organic acids to simpler molecules, in the course of which energy, carbon dioxide and water are given out. Atmospheres low in O₂ (1-5%) and high in CO₂ (5-10%) have been used to extend the shelf-life of fresh-cut fruits and vegetables by reducing respiration, product transpiration and ethylene production, as O₂ is involved in the conversion of 1-amino- cycloprane-1-carboxylic acid to ethylene (Yang & Hoffman, 1984). In general, an inverse relationship has been shown between respiration rates of fruits and vegetables and their postharvest shelf-life. Reduced O₂ and high CO₂ levels have also been proved to effectively control enzymatic browning, firmness and decay of fresh-cut fruits and vegetables. Besides, the proliferation of aerobic spoilage microorganisms can be substantially delayed with reduced O₂ levels (Alejandra Rojas-Grau *et al.*, 2009).

After packing, the vegetables were stored in ambient temperature. Temperature and humidity were recorded and close observations were made to record the physico-chemical parameters like moisture content, rotting/decay, acidity, vitamin C and β-carotene of the beans.

Package perforation (%): The perforations on the packets were made by using a puncher machine. The number of perforations on each packet was determined using the following calculation-

$$\text{Area of each packet} = 28 \text{ cm} \times 26 \text{ cm} = 728 \text{ sq cm}$$

$$\text{Diameter of each hole (dia. of puncher rod)} = 0.4 \text{ cm}$$

From these data, number of perforations were calculated to be 29, 58 and 87 for 0.5, 1.0 and 1.5% perforation, respectively.

Shelf life (day): Shelf life of the beans was determined by observing and judging the quality parameters like rotting, shriveling, incidence of disease, etc. with respect to storage days. It was detected when most of the beans of a treatment were still marketable.

Decay/Rotting (%): It is the percentage of the damaged beans. It was also determined by the quality parameters of the beans like rotting, shriveling, incidence of disease, etc.

Physico-chemical analysis: Acidity, vitamin C, β -carotene and moisture content were determined for the fresh beans and at 5th to 8th days of storage. Acidity was determined by titrating against standard NaOH solution, vitamin C (ascorbic acid) by 2,6-Dichlorophenol-Indophenol Visual Titration Method, β -carotene by AOAC (Association of Official Analytical Chemists) Method and moisture content by Oven Drying method. These methods were conducted according to Ranganna (1986).

Sensory evaluation: Sensory analysis uses human panelists and their senses of sight, flavour, taste, touch and bearing to measure the sensory characteristics and acceptability of food products, as well as many other materials (Watts *et al.*, 1989). Stored beans were examined by a panel of judges comprising of scientific staff for their quality parameters like physical appearance, texture/shrinkage, rotting/decay and overall acceptance. Hedonic scale was used to mark the different parameters. In this scale 'like extremely' is given the highest score of 9 and 'dislike extremely' is given the lowest score of 1. Others are given intermediate scores. The data were analyzed for ANOVA in completely randomized design (CRD) under computerized statistical methods of M-stat and least significant difference (LSD) was used to compare the means.

Treatments

T₁ = Packet with zero perforation

T₂ = Packet with 0.5% perforation

T₃ = Packet with 1.0% perforation

T₄ = Packet with 1.5% perforation

T₅ = Control (without packet)

C₀ = Without chlorine water treatment

C₁ = With chlorine water treatment

Results and Discussion

Data on physico-chemical parameters (moisture content, total acid, vitamin C and β -carotene) and rotting/decay of beans were analyzed at 5th, 6th, 7th and 8th day

of storage at ambient temperature. Temperature was recorded during the experiment as 20-25°C (max.) and 14-16°C (mn.). Again, humidity was recorded as 65% - 85% (at 9:00 am) and 50% - 70% (at 4:30 pm). Since the effect of packaging technique and the combined effect of chlorination and packaging technique were significant in all cases, only the combined effects are described for interpretation as shown in the Table 1 to 3.

Table 1 shows that beans packed in zero perforated packets (C_1T_1 treatment) conserved maximum moisture content (88.33%) followed by CoT_1 after 8 days of storage at ambient temperature as shown in the Table 1. The storage of the beans in the polypropylene packets conserved the moisture hence prevented shrinkage and reduced the weight loss. Beans kept in bulk without packaging lost moisture drastically and shriveled rapidly. On the other hand, beans in the perforated packets lost moisture with respect to perforated openings but slower than bulk and open storage.

Table 1. Combined effect of chlorine water treatment and packaging techniques on moisture content and decay/rotting of country beans during storage.

Treatments	Storage periods, days				
	0d	5d	6d	7d	8d
	Moisture content, %				
C_0T_1		88.29a (69.97)	88.03ab (69.73)	87.19b (69.00)	87.71b (69.45)
C_0T_2		87.85abc (69.58)	85.21d (67.36)	86.64c (68.54)	86.38c (68.32)
C_0T_3		87.04c (68.88)	84.72a (66.96)	84.90e (67.10)	84.65e (66.91)
C_0T_4		87.22bc (69.04)	83.67e (66.14)	84.21f (66.56)	84.23ef (66.57)
C_0T_5		79.61 e (63.13)	-	-	-
C_1T_1	89.15	88.74a (70.37)	88.44a (70.10)	88.40a (70.06)	88.33a (70.00)
C_1T_2		88.20ab (69.88)	87.93b (69.64)	86.90bc (68.76)	86.84c (68.70)
C_1T_3		86.90c (68.75)	86.54c (68.45)	86.01d (68.01)	85.76d (67.80)
C_1T_4		84.90d (67.14)	84.82d (67.04)	84.57ef (66.84)	84.12e (66.49)
C_1T_5		79.42e (63.11)	-	-	-
CV (%)		0.73	0.46	0.50	0.46
Level of significance		*	*	*	*

Table 1. Cont'd.

Treatments	Storage periods, days				
	0d	5d	6d	7d	8d
	Decay/rotting, %				
C ₀ T ₁	15.80g (23.41)	37.54d (37.77)	39.42e (38.88)	40.14g (39.30)	
C ₀ T ₂	33.19c (35.16)	4.00c (39.22)	48.70c (44.23)	61.16c (51.43)	
C ₀ T ₃	40.43eb (39.47)	46.23b (42.82)	53.19b (46.81)	63.62b (52.89)	
C ₀ T ₄	38.12c (38.11)	48.70a (44.23)	57.40a (49.23)	70.58a (57.13)	
C ₀ T ₅	54.64a (47.65)	-	-	-	
C ₁ T ₁	0	5.94h (14.09)	20.73e (27.06)	26.09f (30.70)	10.29h (18.70)
C ₁ T ₂		29.42f (32.83)	36.38d (37.08)	44.49d (41.82)	52.17f (46.23)
C ₁ T ₃		31.88e (34.36)	40.72c (39.64)	47.10c (43.32)	54.35e (47.48)
C ₁ T ₄		35.07d (36.30)	40.87c (39.73)	43.48d (41.24)	56.81d (48.90)
C ₁ T ₅		53.19a (46.81)	-	-	-
CV (%)	1.84	1.42	1.69	1.36	
Level of significance	*	*	*	*	

d= Days, *=Significant at 5% level of probability. Figures in the parenthesis indicate the transform value of the original

At 8th day of storage period, beans treated with chlorine and packed in sealed polypropylene packets (combined effect of treatment C₁T₁) had minimum rotting/decay (10.29%) followed by the treatment C₀T₁ (40.14%) as shown in the Table 1. The rotting/decay of the beans was minimum as these were washed with chlorine water before packing that supports to those found by Giraldo (1977). The rotting/decay in the perforated packets was higher due to two reasons, firstly these packets did not conserve much moisture to prevent shriveling and secondly the little condensed moisture lead the shriveled beans to rot rapidly.

A substantial reduction was noted in ascorbic acid (vitamin C) and β -carotene (vitamin A) contents of the beans during storage. The reduction could be due to both oxidative and non-oxidative changes as described by Eskin (1979) and Land (1962). Such changes altered the colour of the beans and lowered the nutritive value of the beans. In case of combined effect, the maximum vitamin C

and β -carotene retention was observed in treatment C₁T₁ (15.65mg/100g) and C₁T₄ (11.76 μ g/g) followed by the treatment C₀T₁ (10.62 mg/100g) and C₀T₁ (10.45 μ g/g), respectively, at 8th day of storage period (Table 2). Again maximum acidity retention was observed in C₀T₁ (0.29%) followed by C₀T₂ (0.28%) at 8th day of storage (Table 2). These chemical and nutritional compositions and changing behaviours of the stored country beans support to those found by Salunkhe (1991).

Table 2. Combined effect of chlorine water treatment and packaging techniques on chemical and nutritional parameters of country beans during storage.

Treatments	Storage periods, days				
	Od	5d	6d	7d	8d
Vitamin C, mg/100g					
C ₀ T ₁		14.92d	15.26b	11.89b	10.62b
C ₀ T ₂		17.23b	10.55f	11.72b	9.27d
C ₀ T ₃		13.96e	15.47b	10.30c	8.56e
C ₀ T ₄		16.45c	13.92c	11.84b	8.05f
C ₀ T ₅	24.13	11.11i	-	-	-
C ₁ T ₁		20.47a	19.94a	17.69a	15.65a
C ₁ T ₂		12.91fg	11.91e	10.07c	7.95f
C ₁ T ₃		13.41ef	13.37c	12.13b	10.07c
C ₁ T ₄		12.53gh	12.54d	10.49c	10.08c
C ₁ T ₅		12.04h	-	-	-
CV (%)		2.39	3.23	2.60	2.35
Level of significance		*	*	*	*
β - carotene, μ g/g					
C ₀ T ₁		12.28bc	10.51bc	10.52b	10.45b
C ₀ T ₂		11.81bc	8.72d	8.26e	7.61d
C ₀ T ₃		11.28c	8.14de	7.87f	7.31d
C ₀ T ₄		9.45d	7.48e	6.79g	5.87f
C ₀ T ₅	22.26	9.35d	-	-	-
C ₁ T ₁		15.76a	11.16b	8.75d	6.58e
C ₁ T ₂		12.93b	10.33c	9.04c	8.34c
C ₁ T ₃		12.43bc	12.29a	8.26e	6.73e
C ₁ T ₄		12.84b	12.62a	12.15a	11.76a
C ₁ T ₅		11.24c	-	-	-
CV (%)		5.32	5.01	2.05	2.92
Level of significance		*	*	*	*

Table 2. Cont'd.

Treatments	Storage periods, days				
	0d	5d	6d	7d	8d
Total acid, %					
C ₀ T ₁	0.30a	0.30a	0.30c	0.29a	
C ₀ T ₂	0.27c	0.17h	0.30b	0.28c	
C ₀ T ₃	0.23e	0.26b	0.25d	0.24f	
C ₀ T ₄	0.21 f	0.28c	0.19f	0.22h	
C ₀ T ₅	0.1 7g	-	-	-	
C ₁ T ₁	0.23e	0.23f	0.19f	0.24e	
C ₁ T ₂	0.28e	0.29b	0.17g	0.28b	
C ₁ T ₃	0.23e	0.22g	0.36a	0.23g	
C ₁ T ₄	0.25d	0.25e	0.25e	0.27d	
C ₁ T ₅	0.50h	-	-	-	
CV (%)	5.32	5.01	2.05	2.92	
Level of significance	*	*	*	*	

T₁ = Packet with zero perforation,
T₂ = Packet with 0.5% perforation,
T₃ = Packet with 1.0% perforation,
T₄ = Packet with 1.5% perforation,
T₅ Control (without packet),

C₀ = Without chlorine water treatment
C₁ = With chlorine water treatment,
d= Days,
* = Significant at 5% level of probability

The sensory evaluation of the stored bean was conducted by a panel of 5 judges at 5th and 8th day of storage of the bean. The comments of the evaluation on physical appearance, texture, shriveling, rotting/decay and overall acceptance for combined effect are presented in Table 3. In case of combined effect, the highest score for acceptability was for the treatment C₁T₁ (7.83) followed by C₁T₂ (7.33) for 5th day of storage and C₁T₁ (7.50) followed by C₀T₁ (6.83) for 8th day of storage, respectively. Prevention of shrinkage by moisture conservation and reduction of rotting/decay through combined effect of chlorine pretreatment and packaging technique leads the beans to the highest acceptability even after 8 days of storage at ambient temperature.

Table 3. Sensory evaluation of stored country beans in case of combined effect of chlorine water treatment and packaging techniques.

Treatments	Mean scores on sensory attributes							
	After 5 days				After 8 days			
	Physical appearance	Texture/Shrinkage	Totting/Decay	Overall acceptability	Physical appearance	Texture/Shrinkage	Totting/Decay	Overall acceptability
C ₀ T ₁	7.67a	8.17a	7.17a	7.17a	7.50a	7.50a	7.00a	6.83a
C ₀ T ₂	5.50bc	7.33b	5.83b	6.33a	5.67b	5.33b	5.17b	5.33b
C ₀ T ₃	6.00b	7.33b	5.83b	5.67b	5.00b	4.83b	4.67bc	4.50c
C ₀ T ₄	6.17b	7.50a	6.50a	6.50a	4.67bc	4.17bc	4.67bc	4.83bc
C ₀ T ₅	2.00c	1.83c	1.83c	2.17c	1.00c	1.00c	1.00c	1.00d
C ₁ T ₁	8.00a	8.33a	7.50a	7.83a	8.00a	7.83a	7.33a	7.50a
C ₁ T ₂	6.50a	7.67a	6.33a	7.33a	6.67a	5.67b	6.00a	5.50b
C ₁ T ₃	6.17b	7.33b	6.00b	6.50a	5.53b	5.17b	5.33b	5.50b
C ₁ T ₄	6.67b	7.67a	7.33a	7.17a	6.00a	5.17b	5.17b	5.33b
C ₁ T ₅	1.67c	2.00c	1.83c	1.83c	1.00c	1.00c	1.00c	1.00d
CV	13.90	8.45	15.49	14.34	12.07	15.22	13.02	12.79
Level of significance	ns	*	ns	ns	ns	ns	ns	ns

T₁ = Packet with zero perforation, 1 = Dislike extremely
 T₂ = Packet with 0.5% perforation, 2 = Dislike very much
 T₃ = Packet with 1.0% perforation, 3 = Dislike moderately
 T₄ = Packet with 1.5% perforation, 4 = Dislike slightly
 T₅ = Control (without packet), 5 = Neither like nor dislike
 C₀ Without chlorine water treatment, 6 = Like slightly
 C₁ = With chlorine water treatment, 7 = Like moderately
 ns = Not significant at 5% level of probability 8 = Like very much
 * = Significant at 5% level of probability 9 = Like extremely

Conclusion

It could be concluded from the above analysis of findings that beans pre-treated with chlorine water and then packaging in sealed polypropylene is the best for quality and shelf life for 8 days of storage at ambient temperature.

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