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Analysis of physiological loss of weight of vegetables under refrigerated conditions

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ABSTRACT

Comparison between household and laboratory refrigeration of vegetables revealed the lesser loss of physiological weight under laboratory conditions for most of the selected vegetables. The weight loss was maximum for all the vegetables in brown paper and it was minimum in polyethylene bags. In the vegetable baskets, the selected vegetables lost more weight when compared to the vegetables stored in the uppermost and middle compartments of the refrigerator. Percentage of spoilage of vegetables was much higher in LDPE than in polyethylene bags.

Keywords: Vegetables, refrigerated conditions, household.

INTRODUCTION

Fruits and vegetables are perishable products which actively metabolize during the post-harvest phase. Every year 25-30 per cent of the production of fruits and vegetables worth over Rs 4000 crores are wasted due to lack of proper postharvest handling and storage (Devraj 2001).

The use of low temperatures is probably the most important means of extending the storage life of postharvest produce at household level. Hence an attempt was made to test the efficiency of different packaging materials on physiological loss of weight and to examine the effect of storage temperature variations in the different shelves of refrigerator on the performance of various packaging materials.

METHODOLOGY

The research design used for the present investigation was exploratory research. An experiment was conducted to collect the required data.

Experiment was conducted under both household and laboratory conditions in the selected sample households having refrigerators. A total of 30 households from university residential area and Koppadkere

residential area were selected. Based on the local availability, eight vegetables (fenugreek, coriander, tomato, chilli, frenchbean, lady's finger, cucumber and carrot) and four packing materials namely, brown paper bag (size 10" x 12"), polyethylene bag (20 micron thickness with size 13" x 16"), plastic container (food graded container of size 18 x 13 x8 cm) and low density polyethylene bag (300 gauge thickness with size 8" x 12") were selected for the study.

Fresh vegetables were purchased in the morning from the local market from a single wholesale shop. Depending upon the nature of the vegetables, these were prepared for storage. Fenugreek and coriander leaves with tender stem were separated from the root and air-dried to remove excess moisture. Tomato, chilli (with trimmed stalks), French beans, lady's finger, cucumber and carrot (with trimmed taproot and stem plates) were washed with bore water and air-dried to remove excess moisture.

The pre-treated vegetables, tomato, chilli, French bean, cucumber, carrot (500 g each), fenugreek and coriander (100 g each) and lady's finger (250 g) were packed in the selected packing materials and stored in the refrigerators in the selected households and also in the laboratory refrigerators for physical and physiological assessment.

The packed vegetables were stored separately in the different shelves to examine the effect of different compartments viz upper and middle shelves and vegetable baskets. During storage, the physiological loss of weight was recorded on every alternate day using 9 point Hedonic scale. This procedure was continued till 25 per cent of the total weight of the stored vegetables was lost either due to physiological loss of weight or due to change in appearance, colour, decay or texture.

Physiological loss of weight (PLW)

For determining PLW of all vegetables, the weight of the vegetables was recorded and the total loss of physiological weight was then calculated by subtracting the final weight of the vegetables from the initial weight. The results were then expressed in percentage using following formula:

$$\% \text{ PLW} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

RESULTS AND DISCUSSION

Table 1 depicts the comparative analysis of cumulative physiological loss of weight of the vegetables under household and laboratory conditions and variance between the packing materials and critical differences between the means.

Comparison between the household and laboratory refrigerators indicated that the loss of cumulative physiological weight of most of the vegetables was less under laboratory refrigeration. However, the difference was significant for fenugreek (t=3.2), beans (t=9.47) and carrot (t=3.72) in brown paper bags, while in polyethylene bags significant differences were observed for all the vegetables except coriander (t=2.34). The CPLW differed significantly at one per cent level in LDPE bags in case of all the vegetables except tomato and carrot (t=2.33 and 1.4, respectively).

Comparison between the mean values of CPLW among the selected packing materials indicated that the weight loss was maximum in brown paper bags for all the vegetables. Minimum weight loss was observed for fenugreek in polyethylene bags (X = 3.94 g) followed by LDPE bags (X = 7.67 g).

The performance of polyethylene bags for coriander storage was good with the minimum loss of physiological weight (X=4.69 g) as compared to LDPE bags (X= 7.73 g) and plastic containers (X = 7.61 g). Thus the critical difference between the polyethylene bags and plastic containers was significant.

With regard to tomato, the weight loss was minimum in polyethylene bags (X = 3.91 g) and maximum (X = 13.06 g) in plastic containers and in LDPE bags the loss was 8.50 g thus CD indicating a significant difference between the packing materials. The CPLW of chilli was minimum in polyethylene bags (X = 28.84 g) and LDPE bags (X =34.62 g). The statistical analysis revealed a significant difference between polyethylene bags and plastic containers, while no difference was observed between plastic containers and LDPE bags.

The loss of CPLW of beans was less (X =5.59 g) in polyethylene bags while in LDPE bags and plastic containers the loss was almost similar (X = 25.02 and 25.86, respectively). The variation between polyethylene and LDPE bags was significant while between LDPE and plastic containers no difference was observed.

The PLW was minimum for lady's finger in polyethylene bags (X= 4.33 g) when compared to LDPE bags (X=12.82 g) and plastic containers (X =14.39 g). However, polyethylene and LDPE bags differed significantly.

In cucumber, minimum CPLW was recorded in polyethylene bags (X = 4.29 g) followed by LDPE bags (X =13.65 g) and plastic containers (X =39.58 g). Thus a significant difference was noticed between the packing materials.

Similarly, there was a significant difference in the CPLW for carrot in all the packing materials. The recorded loss was

Table 1. Analysis of cumulative physiological loss of weight of the selected vegetables in the selected packing materials under household and laboratory refrigeration (N=30)

Vegetables	Mean values of CPLW in different packing materials					
	Brown paper bag	Polyethylene bag	Plastic container	LDPE bag	'F' value	CD value
Fenugreek (100 g)#	30.89	3.94	13.84	7.67	398.21**	2.16
Coriander (100 g)#	33.59	4.69	7.61	7.73	188.28**	3.57
Tomato (500 g)#	51.25	3.91	13.06	8.56	315.10**	4.45
Chilli (500 g)#	115.61	8.89	28.84	34.62	356.80**	8.99
Beans (500 g)#	143.3	5.59	25.86	25.02	1803.76**	5.40
Lady's finger (250 g)#	63.72	4.33	14.39	12.82	774.78**	3.60
Cucumber (500 g)#	129.87	4.29	39.58	13.65	760.96**	7.60
Carrot (500 g)#	135.05	2.28	24.00	14.46	2641.51**	4.32

#	-	Initial weight of vegetables
*	-	Significant at 5% level
**	-	Significant at 1% level

2.28 g, 14.46 g and 24.00 g in polyethylene bags, LDPE bags and plastic containers, respectively.

Further, the analysis of variance was carried out for the vegetables stored under household refrigerators to test the performance of the packing materials. It was found that the CPLW of the selected vegetables differed significantly at one per cent level in the selected packing materials. However, the observed 'F' value for carrot was found to be high (F = 2641.51).

During the investigations the variation in the physiological loss of weight of the selected vegetables was also observed. The weight loss was less under laboratory conditions for most of the vegetables than under household conditions. This may be due to the reason that in households the refrigerators were repeatedly opened by the users and this might have affected the temperature inside the refrigerator and thereby affecting the cooling conditions of the vegetables resulting in their increased rate of respiration. This increased rate of respiration also caused weight loss of the stored vegetables at one per cent level. The weight loss was maximum for all vegetables in brown paper bagd, while the loss was minimum in polyethylene bags.

Polyethylene bags acted as barriers for loss of moisture resulting in build up of high relative humidity in the vicinity of the vegetables and thereby retarded the moisture loss through transpiration. Hence, the reduction in PLW of vegetables in polyethylene bags was observed.

Jitender Kumar et al (1999) also observed that the roots packed in polyethylene packing and stored in zero energy cool chamber lost less weight than those packed in gunny bags in zero energy cool chamber. Hemalatha et al (2000) noticed lowest PLW in poly-bags without vents and highest in poly-bags with the highest percentage of vents.

The effect of storing the vegetables in different compartments viz top and middle shelves and vegetable baskets on PLW was also studied (Table 2). Fenugreek and tomato lost maximum (10.8%) of PLW in plastic containers and loss was more when these were stored in the upper compartment (2.32%), while chilli and lady's finger lost more weight ie 4.22 per cent in plastic containers and it was more in the middle compartment (5.96%). Among the vegetables stored in plastic containers in the vegetable baskets, beans, cucumber and carrot lost maximum weight of 7.86, 8.84 and 9.68 per cent, respectively.

The mean CPLW (%) of selected vegetables in all the three packing materials was minimum for coriander, chilli and cucumber when stored in the upper most compartments while fenugreek tomato, beans, lady's finger and carrot attained

Table 2. Physiological loss of weight of selected vegetables packed in the selected packing materials and stored in the different compartments of the refrigerator

Vegetables	Packing material											
	Polyethylene bag			Plastic container			LDPE bag			Mean PLW		
	UC	MC	VB	UC	MC	VB	UC	MC	VB	UC	MC	VB
Fenugreek	4.8	5.7	4.6	10.8	7.0	12.1	9.0	4.8	5.7	8.20	5.83	7.47
Coriander	7.1	3.8	5.0	4.4	13.0	7.2	3.8	3.8	4.4	5.10	6.87	5.53
Tomato	5.2 (1.04)	5.0 (1.00)	6.2 (1.24)	11.6 (2.32)	6.85 (1.37)	9.9 (2.00)	1.9 (0.38)	4.32.9 (0.86)	6.23 (0.58)	5.38 (1.25)	6.33 (1.08)	(1.27)
Chilli	9.2 (3.08)	11.9 (2.38)	11.5 (2.3)	18.2 (3.64)	21.1 (4.22)	17.9 (3.58)	10.6 (10.6)	10.4 (2.08)	4.61 (0.92)	2.67 (2.5)	14.47 (2.89)	11.33 (6.8)
Beans	15.4 (3.08)	14.8 (2.96)	14.5 (2.9)	24.9 (4.98)	30.4 (6.08)	39.3 (7.86)	25.8 (5.16)	13.2 (2.64)	21.8 (4.36)	22.00 (4.41)	19.47 (3.89)	25.20 (5.04)
Lady's finger	6.60 (2.64)	3.7 (1.48)	5.5 (2.2)	13.6 (5.44)	14.9 (5.96)	18.2 (5.64)	4.2 (1.68)	2.9 (1.16)	8.2 (3.28)	8.10 (4.09)	7.17 (2.87)	10.63 (3.71)
Cucumber	4.2 (0.84)	4.6 (1.48)	10.8 (2.16)	30.7 (6.14)	42.8 (8.56)	44.2 (8.84)	8.0 (1.60)	15.2 (3.04)	11.4 (2.28)	14.30 (2.86)	20.87 (4.17)	22.13 (4.42)
Carrot	6.3 (1.26)	8.6 (1.72)	9.4 (1.88)	38.7 (7.74)	22.8 (4.56)	48.4 (9.68)	12.0 (2.4)	10.2 (2.04)	10.4 (2.08)	19.00 (3.80)	13.87 (2.77)	22.73 (4.55)

Figures in the parentheses indicate percentages

Since the weight of leafy vegetable is in 100 grams, the same figure is for individual percentage also.

UC - Uppermost compartment; MC - Middle compartment; VG - Vegetable basket

minimum CPLW percentage when stored in the middle compartment.

In the vegetable baskets, the selected vegetables lost more weight when compared to the vegetables stored in the upper most compartment or middle compartment. The variation in the weight loss in different shelves of the refrigerator may be attributed to the lower rate of respiration of the selected vegetables due to lower temperature in the uppermost and middle compartments (5°C) as compared to vegetable basket (5.5°C). The rate of respiration generally increases as the storage temperature increases.

The percentage of spoilage (Table 3) among the vegetables was high for tomato in the selected packing materials (23.88% in brown paper bags, 37.78% in polyethylene bags, 39.64% in plastic containers and 76.1% in LDLE bags). Similarly maximum spoilage of lady's finger in polyethylene bags (34.64%) and in LDPE bags (92.2%) was noticed. Likewise percentage of spoilage of cucumber was also more in plastic containers (22.79%) and in LDPE bags (54.88%).

However, spoilage of maximum vegetables (tomato, lady's finger, cucumber and carrot) was noticed when they were

Table 3. Percentage of spoilage of vegetables under refrigeration in the selected packing materials (N=30)

Vegetables	Packaging material and percentage of spoilage			
	Brown paper bag	Polyethylene bag	Plastic container	LDPE with 2 vents
Fenugreek	Terminated (3.8)	26.49	17.70	20.26
Coriander	Terminated (4.27)	22.81	21.40	22.54
Tomato	23.88	37.78	39.64	23.00
Chilli	4.78	20.60	17.83	21.47
Beans	1.65	25.72	15.51	11.25
Lady's finger	Terminated (9.27)	34.64	Terminated (15.80)	8.72
Cucumber	Terminated (11.63)	28.50	22.79	35.10
Carrot	Terminated (10.60)	34.93	18.41	22.90
Total	30.31	231.47	153.28	160.24
Mean	10.10	28.93	21.90	20.03

Figures in the parentheses indicate number of days at the time of termination of experiment

stored in polyethylene bags and LDPE bags but in LDPE bags it was much higher than polyethylene bags.

CONCLUSION

The cumulative physiological loss of weight of all the selected vegetables was maximum in brown paper bags while it was minimum in polyethylene bags. The mean percentage of spoilage of vegetables in all the selected packing materials except brown paper bags was high.

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