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HORTICULTURE

Shelf life extension of fresh-cut spinach

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Abstract

Fresh-cut vegetables are an important and rapidly developing class of convenience foods. Their storage life may be greatly reduced due to their high rates of respiration and transpiration and the possibility of enzymatic and microbiological deterioration. Consequently, the objective of this work was to determine the shelf life and the failure at ribute that conditioned the shelf life of fresh-cut spinach packaged in different packaging materials.Packaging of fresh vegetables is one of the most important steps in the long and complicated journey from grower to consumer. Spinach has a relatively short shelf life. “Shelf life is defined as the time period that a product can be expected to maintain a predetermined level of quality under specified storage conditions”. Shelf life is a function of time, environmental factors, and susceptibility of product to quality change.The maximum shelf life for spinach was observed as 3 days and 14 days when stored in LDPE bags with 5% perforation at ambient and cold storage conditions, respectively.

Highlights

- Shelf life is defined as the time period that a product can be expected to maintain a predetermined level of quality under specified storage conditions.
- The maximum shelf life for spinach was observed as 3 days and 14 days when stored in LDPE bags with 5% perforation at ambient and cold storage conditions, respectively.

Keywords : Shelf-life, Packaging, LDPE.

Vegetables play an important role in meeting the needs of human beings for vitamins and minerals. Amongst all the vegetable, the leafy vegetables have a very high protective food value. Fresh-cut vegetables are an important and rapidly developing class of convenience foods. The suitability of these products is based on their at ributes of convenience and fresh-like quality. The suitability of these products is based on their at ributes of convenience and fresh-like quality. A problem faced by these products is that their storage life may be greatly reduced as compared with the unprocessed raw material from which they are made. This problem may be due to their high rates of respiration and transpiration and the possibility of enzymatic and microbiological deterioration.Therefore, spoilage of fresh-cut vegetables may result from degradation of physiological and sensory characteristics (color, texture, and odour) as well as from microbiological degradation. Indian spinach (Beta vulgaris L.) is one of the most important leafy vegetable consumed all over the country. It is commonly known as “Palak”. It belongs to the Chenopodiaceae, genus “Beta”

species "Vulgaris". Indian spinach is closely related to Beet root and Swiss chord (Singh, 2009). Vegetables hold an important position in balanced diets. Green Leafy Vegetables (GLV) are believed to occupy a modest place as a source of micronutrients including neutraceuticals of nutritional importance like β-carotene, iron, calcium, magnesium, phosphorus, potassium, fiber, folic acid, vitamin K, C and E (Borah *et al*. 2008).

Materials and Methods

The research was carried out at the department of Agricultural Process Engineering, college of agricultural engineering and technology, VNMKV, Parbhani during 2013-14.

Sample Preparation

Fresh spinach (*Beta vulgaris,* L.) (Var. local) were procured after harvesting in the morning hours from commercial plantation located near the Parbhani city. Fresh, uniform size and matured spinach (Var. local) were procured from local farmer, Parbhani. Sorting and grading were done manually to remove diseased and non uniform spinach leaves. Clean leaves were taken for experiment.

Experimental Layout and Design

The design of experiment was carried out by the software: Design Expert Version 8.0.7.1, Full Factorial Design with six responses of packaging materials and two categories of storage conditions.

Independent variables		Treatments	Dependent variables
Packaging system	Storage		
Different packaging systems for spinach	Ambient (S_1)	S_1P_1, S_1P_2, S_1P_3, S_1P_4, S_1P_5, S_1P_6.	Physiological loss in weight (PLW), Yellowing.
	Cold (S_2)	S_2P_1, S_2P_2, S_2P_3, S_2P_4, S_2P_5, S_2P_6.	

Where,

S_1: Spinach leaves stored at ambient condition. S_2: Spinach leaves stored at cold condition.

P_1 : Plastic punnet. P_2: Bamboo basket. P_3: Plastic net bag.

P_4: LDPE bag. P_5: Polyethylene bag. P_6 : LDPE wrapping.

Storage conditions

Ambient storage (Room temperature) (S_1)

The spinach packed in different packaging materials and kept in the Agricultural Process Engineering laboratory for storage. The average temperature and relative humidity were ranged 25 ºC to 35 ºC and RH 55 % to 65 % respectively.

Cold storage (S_2)

Cold storage was used to store the spinach for predetermined temperature at 4 ºC and 90% relative humidity for storage period of fourteen days (Piagentini, 2002).

Physical properties of spinach

Physiological loss in weight (PLW)

For determining physiological loss in weight, sample was weighed accurately at zero days and subsequently on each day. The difference in weight was considered as PLW and percentages calculated using the formula (Koraddi *et al.* 2009).

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

Yellowing

The extent of yellowing was determined by weighing the amount of unroten leaves that turned yellow from the stored sample. Percentage of yellowing was calculated using the formula (Reddy, 2010).

$$\% \text{ Yellowed} = \frac{\text{Weight of yellowed leaves}}{\text{Amount Total sample weight}} \text{ X } 100$$

Results and Discussion

Water loss from the fresh leaves was measured by

the change in weight of samples over the storage period. During the investigation the variation in physiological weight loss (%) and yellowing (%) were observed and showed. From Design Expert ANOVA test, it was observed that effect of packaging materials on physiological weight loss (%) and yellowing (%) of spinach stored at ambient as well as cold conditions were found statistically significant at 5% level of significance. Also the interaction effect between packaging materials P and storage days D i.e. (P x D) was found significant at 5% level of significance. In treatments P_3 and P_2, sample spoiled on the 3rd day of storage period, while in all other treatments sample spoiled on the 4th day of storage period during ambient condition while in cold conditions in treatments P_2 and P_3, sample spoiled on the 7th day of storage period while in treatment P_6 sample spoiled on the 10th day of storage period, and all other treatments sample spoiled after the 14th day of storage period.

Effect of packaging materials on physiological weight loss (%) of spinach stored at ambient condition (S_1):

The weight loss varied between 2.33 % to 18.66 % during storage period. From figure 1 showed, that minimum weight loss was observed in treatment P_4. LDPE bag was found to be better packaging materials as compared to other in respect of minimum physiological weight loss during the storage period of 3 days. These findings are in agreement with the result of Reddy J.B. (2010), for fenugreek leaves packed in LDPE pouches and stored under ambient condition which showed minimum (%) weight loss on 3rd day of storage period. It may be due to low water vapor transmission rate of LDPE bag as compared to all other packaging materials (Piagentini *et al.* 2002). The loss of water in the fresh produce can cause reduction in turbidity, loss of nutritional quality and undesirable changes in colour. The weight loss is mainly caused by water transpiration and respiration (Nagar *et. al.,* 2012).

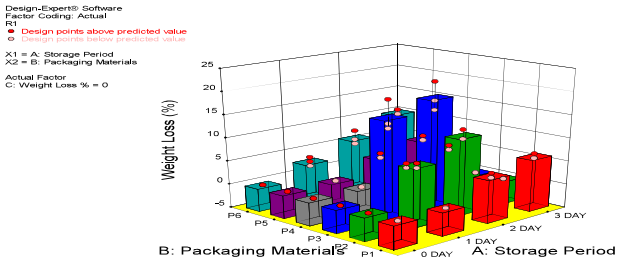

Fig. 1. Effect of packaging materials on physiological weight loss (%) of spinach stored at ambient condition.

Effect of packaging materials on yellowing (%) of spinach stored at ambient condition (S_1):

Figure 2 illustrated that yellowing (%) of spinach increased from 5% to 55% all among the treatments. Yellowing (%) was increased with increase in storage period for all packaging material. LDPE bag was found to be better packaging materials as compared to other in respect of minimum yellowing (b= 26.21) during the storage period of 3 days. 'b' values are derived from colour flex- EZ colorimeter. 'b' values are +ve. Highest +ve 'b' values gives darkest yellow colour of leaf and lesser 'b' values gives degradation in yellow colour. Maximum yellowing (%) was found in treatment P_6. Yellowing (%) was not observed up to 2nd day of storage in treatments P_1, P_4, and treatment P_5 while in treatments P_2 and P_3 yellowing (%) was found from 1st day of storage period. On storage of spinach leaves in different packaging material, many changes occurred such as colour changes from bright green to light green, crisp texture was lost and become soft with partially withered rotten and yellowed leaves on 2nd and 3rd day of storage.

Similar trend was found by Reddy, J.B. (2010) for fenugreek leaves packed in LDPE pouches under the ambient condition showed minimum yellowing (%) during the storage period up to 3 days.

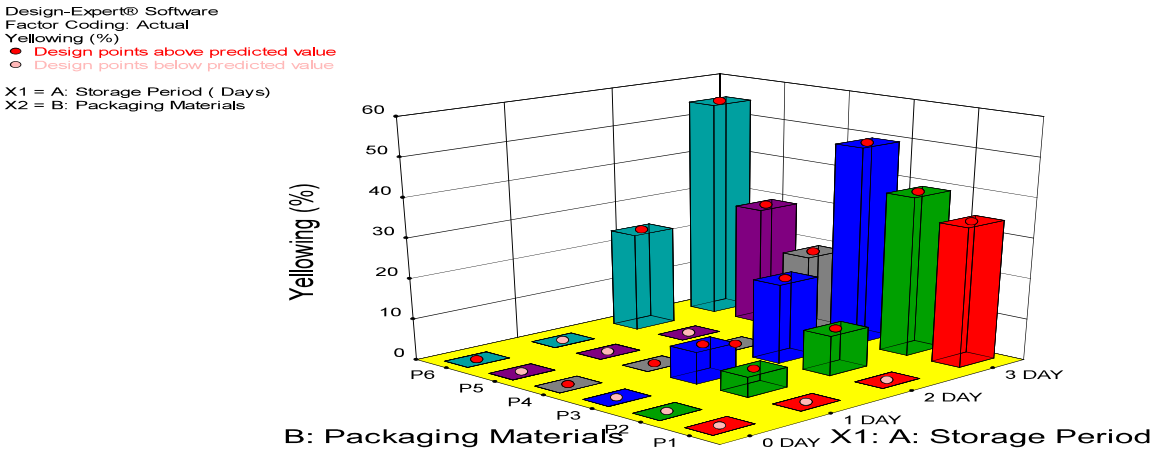

Fig. 2. Effect of packaging materials on yellowing (%) of spinach stored at ambient condition.

Effect of packaging materials on physiological weight loss (%) of spinach stored at cold condition (S_2).

The weight loss varied between 2.00 % to 40.00 % during storage period. Figure 3 investigated that treatment P_4 showed minimum weight loss, it may be due to low water vapor transmission rate of LDPE bag as compared to all other packaging materials (Piagentini *et. al.,* 2002). The weight loss is mainly caused by water transpiration and respiration (Nagar *et. al.,* 2012). Maximum weight loss (%) was found in treatment P_1 spinach packed in plastic punnet.

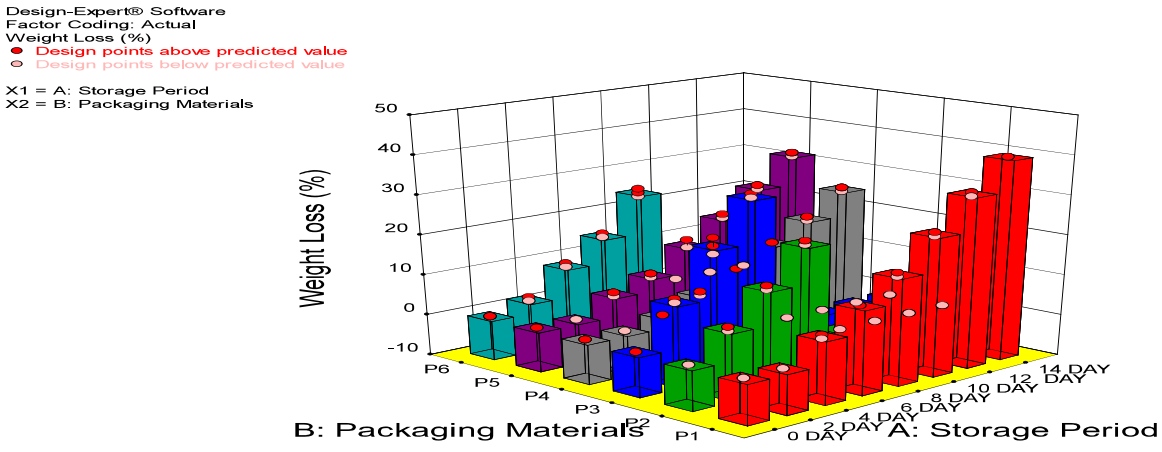

Fig. 3. Effect of packaging materials on physiological weight loss (%) of spinach stored at cold condition.

Weight loss increased with increase in storage period for all packaging material. These findings are in agreement with the result of Pathan, (2003), for spinach leaves packed in (300 gauge) polyethylene bag stored at 5°C under cold condition which showed minimum (%) weight loss on 14th day of storage period.

Effect of packaging materials on yellowing (%) of spinach stored at cold condition (S_2)

Figure 4 illustrated that yellowing (%) of spinach increased from 2% to 78.66% among the treatments. LDPE bag was found to be bet er packaging materials as compared to other in respect of minimum yellowing (b= 33.12) during the storage period of 14 days. 'b' values are derived from colour flex- EZ colorimeter. 'b' values are +ve. Highest +ve 'b' values gives darkest yellow colour of leaf and lesser 'b' values gives degradation in yellow colour. Yellowing (%) was increased with increase in storage period for all packaging material.

On storage of spinach leaves in different packaging material, many changes occurred such as colour changes from bright green to light green, crisp texture was lost and become sof with partially withered rot en and yellowed leaves start from 7th day of storage till the end of shelf life period of 14th day. Similar trend was found by Reddy, (2010) for rajagira leaves packed in (150gauge) polypropylene pouches under the refrigerated condition showed minimum yellowing (%) during the storage period of 17th days.

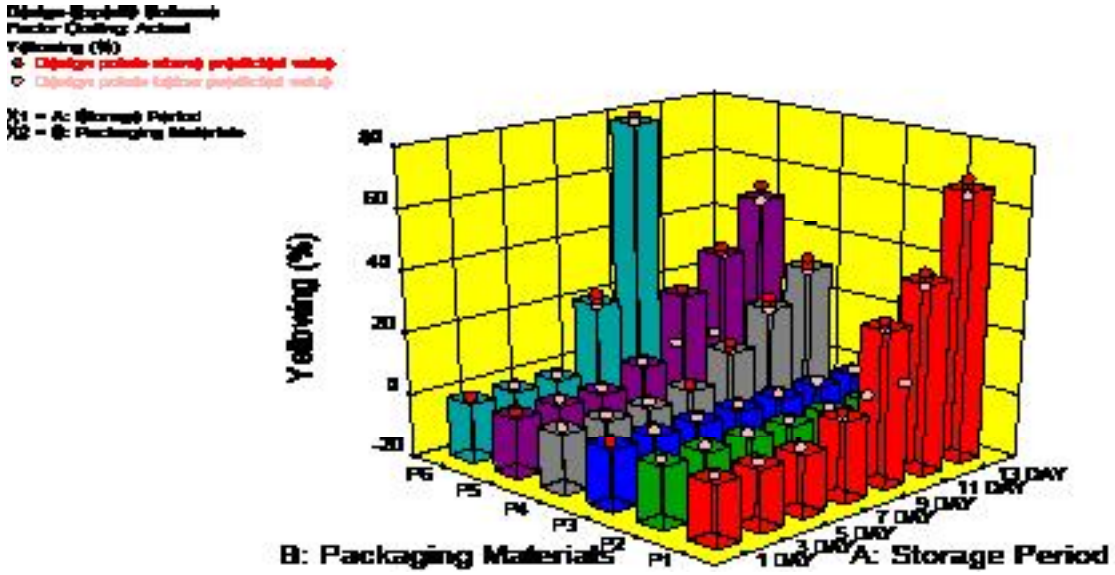

Fig. 4. Effect of packaging materials on yellowing (%) of spinach stored at cold condition.

Conclusion

Quality characteristics such as physiological weight loss (%), yellowing (%), were found to bet er in spinach packed in LDPE bag followed by spinach packed in polyethylene bag with 5% perforation for both storage conditions. LDPE bag was found to be best suitable packaging material. The maximum shelf life for spinach was observed as 3 days and 14 days when stored in LDPE bags at ambient and cold storage conditions, respectively.

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