AJHS
Asian Journal of Home Science
Volume **10** | Issue 1 | June, 2015 | 123-128

DOI: 10.15740/HAS/AJHS/10.1/123-128
e ISSN-0976-8351 ■ Visit us: *www.researchjournal.co.in*

Research Paper

Study on the effect of packaging on the freshness of spinach

■ SHWETA PRIYADARSHINI **AND** MUKTA SINGH

Received: 19.01.2015; **Revised:** 05.04.2015; **Accepted:** 20.04.2015

■ **ABSTRACT :** The post harvest industry is expected to supply good quality fruit and vegetables to consumers throughout the year from various and distant fields. Post harvest products are living and respiring materials and from field to fork, several factors influence quality. In this study, focus was mainly on leafy green vegetables and so spinach was taken as the subject. The primary aim of this study was to determine the effect of perforated packaging and temperature on the retention of ascorbic acid and iron in spinach. Organically grown, fresh spinach leaves were taken from kitchen garden and were separated into three equal parts. Two portions (Sample 1 and 2) were packed in 40 micron thick plastic film and after heat sealing the packets were perforated with a medical needle. Sample 1 and sample 3 (unpacked), were stored at 4°C and sample 2 was stored at -18°C. After 6 days of storage fresh spinach (sample 4) was taken from same kitchen garden. All the samples were then evaluated for iron and ascorbic acid. The iron content in sample was determined by UV- Spectrophotometry method and the ascorbic acid content was determined by 2, 6 dichloroindophenol titrimetric method (AOAC). Furthermore, weight loss was evaluated and sensory analysis was used for describing the quality changes such as physical appearance, texture/shrinkage and to ascertain the overall acceptability. The result of sensory analysis was then subjected to ANOVA, for statistical analysis. In this study greater retention of ascorbic acid (84.6 %) was observed during storage of sample (sample 1) in perforated plastic film at 4°C as compare to sample 2, stored at -18°C (69.3 %) and sample 3, stored unpacked (58.7 %). The greater retention of iron was also observed in the same sample (85.8 %). It also had the higher overall acceptability as compared to other two samples. Further, it got highest score of 6.8 for overall acceptability on 6th day of storage. Thus, in the present study the quality retention was superior with perforated packaging at 4°C storage temperature.

■ **KEY WORDS:** Spinach, Perforated packaging, Retention of iron, Retention of ascorbic acid, Temperature

■ **HOW TO CITE THIS PAPER :** Priyadarshini, Shweta and Singh, Mukta (2015). Study on the effect of packaging on the freshness of spinach. *Asian J. Home Sci.*, **10** (1) : 123-128.

See end of the paper for authors' affiliations

SHWETA PRIYADARSHINI
Department of Home Science, Mahila Mahavidhyalaya, Women College (B.H.U.) VARANASI (U.P.) INDIA

The growing population and improved public awareness on the unique nutritional qualities of vegetables has led to unprecedented rise in consumer demand for fresh vegetables. Also the requirement for ready-to-use vegetables has increased, in the recent time and this has led to the introduction of

many new technologies in packaging industry as well as there is increase in type of packaging material too but for the small scale rural farmers, these expensive technologies are far from reach and so in rural areas, farmers suffer from significant losses, especially when it comes to perishable crops. This warrants for a low-cost simplified storage method. Hence, this study was focused mainly on the applicability of such method and to determine the effect on the retention of ascorbic acid and iron in spinach.

Alabadan *et al.* (2008) conducted a study to assess the effect of packaging materials on some nutritional qualities of fruit and vegetables (garden egg, banana and tomatoes) stored in a passive evaporative cooler. They asserted that the shelf-life and qualities of the stored produce in the perforated plastic container is better maintained as compare to sisal sack and control. Pandrangi and Laborde (2004) examined the retention of folate, carotenoids and other characteristics in commercially packed fresh spinach. They averred that substantial losses of nutrients occurred at each storage temperature. Only 53 per cent of folate in packaged spinach was retained after 8d, 6d and 4d at 4^0C, 10^0C and 20^0C, respectively. Carotenoid losses, was reported to increase with temperature (Labib *et al.*, 1997).

The overall objective of this study was to determine the quality changes as effect of perforated packaging and temperature. Sensory analysis was used for determining the attributes such as physical appearance, shrinkage and to describe the quality changes, ascorbic acid and iron content was evaluated at the last day of storage and was compared with that of fresh spinach which was the control sample.

■ RESEARCH METHODS

The materials used and methods followed during the period of study are described in sequence in this paper.

Pre-preparation of samples :

Sample selection :

Organically grown, pesticides free, spinach leaves were taken from kitchen garden, by the researcher. The leaves were sorted, washed and left to dry in shade.

Packaging construction :

Spinach leaves were separated in three 50 g portions. Two of the portions were packed in 40 micron thick plastic film. Packaging was then heat sealed leaving no physical holes. Both of the packets were then perforated with a number of holes using a cheap medical needle having diameter of 0.3-1mm (Triplicates of the sample were prepared).

Samples :

Number 1- Packed in perforated plastic film (40µm thick), stored at 4^0C.

Number 2- Packed in perforated plastic film (40µm thick), stored at -18^0C.

Number 3- Unpacked stored at 4^0C.

Number 4- Control (fresh spinach obtained on the same day the samples were evaluated).

Weight loss :

At each sampling interval, samples were removed from the chamber and weighed using a top loading balance (average weight loss per sample was expressed as a percentage of initial fresh weight).

Sensory evaluation :

Attributes such as physical appearance, texture/ shrinkage was evaluated by a panel of 6 semi trained members. They were scored on 9 point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely). The result was then subjected to ANOVA.

Quality analysis :

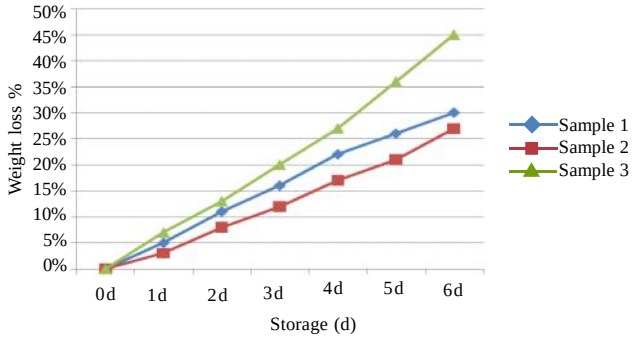
All the four samples were then evaluated for iron and ascorbic acid using UV-Spectrophotometry method and 2, 6 dichloroindophenol titrimetric method (AOAC), respectively. The iron and ascorbic acid content in sample no. 1, 2 and 3 was then compared with sample no. 4 (control sample), to assess the deterioration.

■ RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented in Table 1 and Fig. 1 to 3.

Sensory evaluation :

The sensory evaluation of the stored samples (sample no. 1, 2 and 3) was conducted on 3rd and 6th day



Note: Sample no.4 was not included in sensory analysis as it was control sample and was obtained on the last day of storage to provide a reference

Fig. 1 : Weight loss in the samples

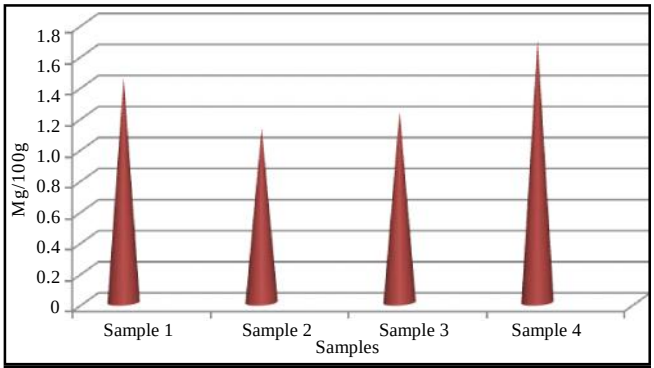


Fig. 3 : Retention of iron (%) in packaged spinach stored at 4°C and -18°C (sample no. 1 and 2, respectively), unpacked spinach stored at 4°C (sample no. 3) and in control sample (sample no. 4).

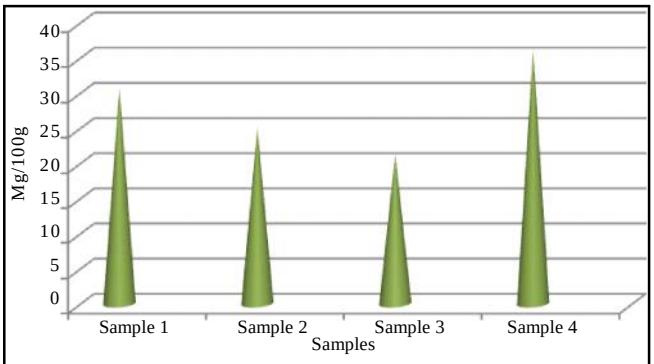


Fig. 2 : Retention of ascorbic acid (%) in packaged spinach stored at 4°C and -18°C (sample no. 1 and 2, respectively), unpacked spinach stored at 4°C (sample no. 3) and in control sample (sample no. 4).

of storage. Scores on physical appearance, shrinkage and overall acceptability are present in Table 1. The highest score for acceptability was obtained by sample no. 1 on 3rd day (8.5) followed by sample no. 2 (7.5). Sample no. 3 which was stored at 4^0C, unpacked showed maximum of shrinkage and its overall acceptability was very poor compare to other two samples. Less change in physical appearance was observed in sample no.1, which was stored at 4^0C, with less of shrinkage as compared to sample no. 2 which was stored at -18°C, though the shrinkage and the changes in appearance is supposed to be less at low temperature (Ares *et al.*, 2008a and b). This could be owing to the freezing injury which happens to some vegetable crops of tropical origin when stored

Table 1 : Sensory evaluation of the samples

Samples	Mean score on sensory attributes					
	3rd day			6th day		
	Physical appearance	Texture/ shrinkage	Overall acceptability	Physical appearance	Texture/ shrinkage	Overall acceptability
Sample 1	8. 7	8.5	8.5	8.5	7.5	6.8
Sample 2	7.8	8.3	7.5	7.5	6.8	5. 7
Sample 3	6.5	6.7	6.333333	6.3	3.3	2. 7
ANOVA co-efficient	14.02	22.2	16.71	52.5	58.80	75.61
Level of significance	NS	NS	NS	NS	NS	NS

Sample 1- packed in perforated plastic film and stored at 4°C
Sample 2- packed in perforated plastic and stored at -18°C
Sample 3- unpacked and stored at 4°C
NS- Non-significant at 5% level of probability

Hedonic scale : By Dr. David R Peryam
1 = Dislike extremely
2 = Dislike very much
3 = Dislike moderately
4 = Dislike slightly
5 = Neither like nor dislike
6 = Like slightly
7 = Like moderately
8 = Like very much
9 = Like extremely

Note: Sample 4 was not included in sensory analysis as it was control sample and was obtained on the last day of storage to provide a reference; NS=Non-significant

below freezing point (0^0C).

Quality and nutritional losses in sample no. 1 (packed in perforated plastic film and stored at 4^0C):

Changes in quality and nutrient content were much less pronounced in sample no. 1, stored at 4^0C than in sample no. 2 stored at -18^0C. There was about 30 per cent weight loss after 6 days of storage. Similar results were observed by Padrangi and Laborde (2004) who studied effect of storage temperature (4^0C, 10^0C and 20^0C) on retention of folate, carotenoids and other quality characteristics in commercially packaged fresh spinach. When commercially packaged fresh spinach was stored at 4^0C for 8 days, there was about 31 per cent (mean value) weight loss after 6 days and about 38 per cent (mean value) weight loss after 8 days.

There was about 84.6 per cent retention of ascorbic acid after storage at 4^0C for 6 days as compared to the control sample *i.e.* the fresh spinach obtained from the same source as the other samples. Favell (1998) reported only 20 per cent retention of ascorbic acid in spinach stored under refrigerated temperature (4^0C) for 7 days (Fennema, 1977; Fonseca *et al*., 2002 and Giannakourou and Taoukis, 2003). Howard *et al*. (1999) reported 87 per cent retention of ascorbic acid in broccoli stored at 4^0C for 21 days. The differences in ascorbic acid retention observed between the present study and other studies may be due to several factors, such as conditions under which the produce was harvested and analyzed, exposure to heat and/or oxygen or perhaps higher lower ascorbate oxidase activity in the vegetable. Iron retention was about 85.8 per cent as compared to control sample, higher than other two samples. Mepba *et al*. (2007) in Nigeria also reported decrease in retention of iron content after storage, who studied effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. Here, it can be emphasized that action of oxidizing enzymes may have caused the nutrient loss.

Quality and nutritional losses in sample no. 2 (packed in perforated plastic film and stored at -18^0C) :

Sample no. 2 stored at -18^0C, appeared more shriveled and wilted as compared to Sample no. 1 stored at 4^0C, though the weight loss in sample no. 2 was 27 per cent as compared to 30 per cent weight loss in sample no. 1. The significant change in appearance can be due to the freezing injury that leads to weakening of tissue and causes cellular damage and as the moisture loss is less at low temperature there was less weight loss in sample no. 2 as compared to other two samples stored at 4^0C. Snehal and Barrett (2009) reported retention of 75.2 per cent of moisture in *Cassia tora* (African leafy vegetables) after 30 days, who studied effects of storage condition and domestic cooking on the quality and nutrient content of African leafy vegetables (*Cassia tora* and *Corchorus tridens*). Rahman *et al*. (2009) reported 85.21 per cent of moisture after 6 days of storage in country beans stored in polypropylene with 0.5 per cent perforation. In the present study, moisture loss was not calculated but as the weight loss proportional to moisture loss, it can be concluded, that here the moisture loss is more as compared to that observed in other studies. The differences could be attributed to biological variation in the leaves and exposure to heat and/or oxygen. Iron retention was about 66.3 per cent as compared to control sample. There isn't any explanation available regarding less retention of iron in sample stored at -18^0C as compared to that stored at - 4^0C.

Ascorbic acid concentration was significantly higher in control sample *i.e.* the fresh spinach obtained from the same source as the other samples than the sample no. 2, stored at -18^0C. There was about 69.3 per cent retention of ascorbic acid at -18^0C after 6 days storage as compared to control sample. This result may be explained by the oxidation of ascorbic acid to dehydroascorbic acid or to 2, 3-diketogulonic acid. Several previous studies (Howard *et al.,* 1999; Murcia *et al*., 2000 and Korus *et al*., 2002 and Lisiewska *et al.*, 2002) have considered the effects of frozen storage for 6–12 months on vegetables such as broccoli, carrots, green beans, green peas and spinach and reported between 37 and 80 per cent retention of initial ascorbic acid.

The differences in ascorbic acid retention in present study and other studies could be due to the reason that in other studies vegetables were blanched before freezing but not in this study. Blanching causes inactivation of ascorbate oxidase, which causes the oxidation of ascorbic acid to dehydroascorbic acid. Thus, it results in greater ascorbic acid retention during frozen storage.

In this study, it was observed that ascorbic acid retention in sample stored at 4^0C was more as compared to that in sample stored at -18^0C. Similar result was

reported by Snehal and Barrett (2009), who studied effects of storage condition (20^0C for 6 days, 4^0C for 14 days and -18^0C for 90 days) and domestic cooking on the quality and nutrient content of African leafy vegetables (*Cassia tora* and *Corchorus tridens*). One possible explanation for this could be that the enzyme ascorbate oxidase, which is responsible for the oxidation of ascorbic acid to dehydroascorbic acid, most likely gets compartmentalized and, therefore, separated from its substrate under these warmer storage conditions Yamaguchi *et al*. (2003). Freezing, however, causes cells to rupture, allowing the enzyme to come into contact with its substrate and oxidizing ascorbic acid into dehydroascorbic acid, which was not accounted for in the present study.

Quality and nutritional losses in sample no. 3 (unpacked) :

Changes in quality and nutrition were significantly high in sample no. 3, which was stored unpacked at 4^0C as compared to other two samples. There was approx 45 per cent weight loss after 6 days of storage. There was visible wilting and curling and concomitant decrease in freshness just during 2 days of storage due to rapid transpiration. There was about 58.7 per cent retention of ascorbic acid and 72.8 per cent retention of iron in sample no. 3 as compared to control sample. Both quality and nutritional losses were greater in sample no. 3 as there was no antagonistic factor (packaging) working in this case as in other two samples (Koseki and Itoh, 2002 and Luo *et al.*, 2004).

Packaging has the potential to reduce moisture loss, restrict the entrance of oxygen, lower respiration and retard ethylene production and so in other two samples quality and nutrition was better maintained.

Conclusion :

Both ascorbic acid and iron content of all the three samples decreased significantly with greater loss of ascorbic acid occurring in sample no. 3 (spinach stored unpacked at 4^0C) and greater loss of iron occurring in sample no. 2 (spinach packed in perforated plastic film and stored at- 18^0C). Previous studies have reported that lowering the storage temperature results in greater retention of ascorbic acid but in this study greater retention of ascorbic acid was observed during storage of sample (sample no. 1) in perforated plastic film at 4^0C. It could be that in other studies vegetables were blanched before freezing but not in this study. Blanching causes inactivation of ascorbate oxidase, which causes the oxidation of ascorbic acid to dehydroascorbic acid. Thus, it results in greater ascorbic acid retention during frozen storage.

The greater retention of iron was also observed in the same sample. Blanching prior to frozen storage may reduce the activity of enzymes catalyzing the continual loss of both ascorbic acid and chlorophyll during storage. Thus further research might address leaves stored blanched and unblanched under frozen temperatures.

It also had the higher overall acceptability as compared to other two samples. Further, it got highest score of 8.7 for physical appearance followed by sample no. 2 which got a score of 7.8 for physical appearance on 3rd day of storage.

Thus, in this present study the quality retention was superior with this packaging at 4^0C storage temperature.

Authors' affiliations:
MUKTA SINGH, Department of Home Science, Mahila Mahavidhyalaya, Women College (B.H.U.), VARANASI (U.P.) INDIA

■ REFERENCES

Alabadan, B.A., Sunmonu, M.O. and Sunmonu, T.O. (2008). Effect of packaging materials on some nutritional qualities of fruit and vegetables stored in a passive evaporative cooler. *Asian J. Food Agro-Indian*, **1** (3) : 184-196.

Ares, G., Lareo, C. and Lema, P. (2008a). Sensory shelf-life of butterhead lettuce leaves in active and passive modified atmosphere packages. *Internat. J. Food Sci. Technol*., **43** (9) : 1671-1677.

Ares, G., Martinez, I., Lareo, C. and Lema, P. (2008b). Failure criteria based on consumers' rejection to determine the sensory shelf life of minimally processed lettuce. *Postharvest Biology Technol.,* **49** (2) : 255-259.

Favell, D.J. (1998). A comparison of the vitamin C content of fresh and frozen vegetables". *Food Chem.,* **62** (1) : 59–64.

Fennema, O. (1977). Loss of vitamins in fresh and frozen foods. *Food Technol.,* **31**(12): 32–38.

Fonseca, S.C., Oliveira, F.A.R., and Brecht, J.K. (2002). Modelling respiration rate of fresh fruits and vegetables for modified atmosphere packages: A review. *J. Food Engg.,* **52** (2) : 99-119.

Giannakourou, M.C. and Taoukis, P.S. (2003). Kinetic modelling of vitamin C loss in frozen green vegetables under variable storage conditions. *Food Chem.,* **83** (1) : 33–41.

Howard, L.A., Wong, A.D., Perry, A.K. and Klein, B.P. (1999). β-carotene and ascorbic acid retention in fresh and processed vegetables. *J. Food Sci.,* **64** (5) : 929–936.

Kader, A.A. (2002). Postharvest biology and technology: an overview. In: *Postharvest technology of horticulture crops,* (Ed.) A.A. Kader. University of California, Agriculture and Natural Resource Publication, **3311**: 39-47.

Korus, A., Lisiewska, Z. and Kmiecik, W. (2002). Effect of freezing and canning on the content of selected vitamins and pigments in seeds of two grass pea (*Lathyrus sativus* L.) cultivars at the not fully mature stage. *Nahrung/ Food,* **46** (4) : 233–237.

Koseki, S. and Itoh, K. (2002). Effect of nitrogen gas packaging on the quality and microbial growth of fresh-cut vegetables under low temperatures. *J. Food Protec.*, **65** (2): 326-332.

Labib, A.A.S., Abd, El-Latife S.A. and Omran, H. (1997). Quality indices of Jew's mallow and spinach during frozen storage. *Plant Foods Human Nutr.,* **50** (4) : 333–347.

Lisiewska, Z., Korus, A. and Kmiecik, W. (2002). Changes in the level of vitamin C, β-carotene, thiamine, and riboflavin during preservation of immature grass pea (*Lathyrus sativus* L.) seeds. *Europe Food Res. Technol.*, **215** (3) : 216–220.

Luo, Y.G., Mcevoy, J.L., Wachtel, M.R., Kim, J.G. and Huang, Y. (2004). Package atmosphere affects postharvest biology and quality of fresh-cut cilantro leaves. *Hort. Sci.,* **39** (3) : 567-570.

Mepba, H.D, Eboh, L. and Banigo, D.E.B. (2007). Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. *African J. Food Agric. Nutr. & Develop.*, **7** (1) : 1-18.

Murcia, M.A., L´opez-Ayerra, B., Martinez-Tom'eM, Vera A.M. and Garc´ýa, C.F. (2000). Evolution of ascorbic acid and peroxidase during industrial processing of broccolii. *J. Sci. & Food Agric.,* **80** (13) : 1882–1886.

Pandrangi, S. and Laborde, L.F. (2004). Retention of folate, carotenoids, and other quality characteristics in commercially packaged fresh spinach. *J. Food Sci.*, **69**(9):702-707.

Rahman, Md. Mizanur, Shahjahan, Md., Miaruddin, Md. and Chowdhury, Md. Golum Ferdous (2009). Effect of packaging techniques and chlorination on the quality and shelf-life of country bean (*Lablab niger*). *Bangladesh J. Agric. Res.,* **34** (4): 623-631.

Salveit, M.E. (2004). Respiration metabolism. In: *The commercial storage of fruits, vegetables and florist and nursery stocks*. USDS-ARS, Africulture Handbook No. **66** (draft revised 2004), Ed. K. Gross.

Schouten, R.E. and Cadwallader, K.R. (2004). *Ways of measuring shelf-life and spoilage*. In: *Understanding and measuring shelf-life of Food,* (Ed.) R. Steele. Woodhead Publishing Limited. England. 69-90pp.

Snehal, Prabhu and Barrett, Diana M. (2009). Effects of storage condition and domestic cooking on the quality and nutrient content of African leafy vegetables (*Cassia tora* and *Corchorus tridens*). *J. Sci. & Food Agric.*, **89** (10) :1709–1721.

Srilakshmi, B. (2010). *Food science*, New Delhi, New Age International Pvt. Ltd, Publishers, (5th Ed.). 300-301pp.

Watada, A., Kim, S., Kim, K. and Harris, T. (1987). Quality of green beans, bell peppers and spinach stored in polyethylene bags. *J. Food Sci.,* **52** (6) : 1637–1641.

Yamaguchi, Tomoko, Katsuda, Mamiko, Oda, Yuka, Terao, Junji, Kanazawa, Kazuki, Oshima, Shunji, Inakuma, Takahiro, Ishiguro, Yukio, Takamura, Hitoshi and Matoba, Teruyoshi (2003). Influence of polyphenol and ascorbate oxidases during cooking process on the radical scavenging activity of vegetables. *Food Sci. Technol. Res.,* **9** (1) : 79 – 83.