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Short communication

Effect of modified atmosphere packaging on maintenance of quality in apple

F. A. Khan, A. H. Rather, N. A. Qazi, M. Y. Bhat[1], M. S. Darzi, M. A. Beigh and Imtiyaz Ahmad

Plant Physiology Section, Division of Post Harvest Technology
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir
Shalimar Campus, Srinagar-191121, India
E-mail: fakphtskuastk@rediffmail.com

ABSTRACT

An experiment was conducted to study the effect of modified atmosphere packaging (MAP) on the quality of 'Red Delicious' and 'Golden Delicious' apples. Freshly harvested fruits were wiped clean and (25 µm thick) with varying number of perforations and stored in cardboard boxes at ambient temperature. 'Golden Delicious' showed higher incidence of bitter pit as compared to 'Red Delicious' apples. MAP proved effective in controlling the bitter pit disorder and in maintenance of quality. The least incidence of bitter pit in 'Golden Delicious' was recorded with T_4 (30 x 2 mm perforation) and T_3 (20 x 2 mm) treatment in 'Red Delicious' apples. However, MAP retained more freshness in 'Golden Delicious' than in 'Red Delicious'.

Key words: Apple, modified atmosphere packaging, bitter pit, quality

Bitter pit of apples has long been recognized as a serious physiological disorder of stored apples and limits the local as well as export market resulting in economic losses. Bitter pit has been described as a physiological breakdown of cells under the skin, causing slight depressions, which are generally concentrated around the calyx end of the fruit.

The tissue in the depressed areas is dry and spongy with a bitter taste (Ferguson and Watkins, 1989). This is generally associated with low levels of calcium in the fruit (Perring, 1986); however, the exact cause of bitter pit is not understood (Steenkamp *et al*, 1983; Witney and Kushad, 1990). Application of calcium salts as pre- or post-harvest treatment has long been practiced as a measure to control development of bitter pits in apple (van Goor, 1971). It has been reported that reduction in bitter pit can also be achieved by storing fruits in controlled or modified atmosphere. Modified atmosphere packaging (MAP) refers to the storage of fruits in polymeric films, which restrict transmission of respiratory gases. It is a simple and cheap means of storage but care must be taken to avoid injuriously high CO_2 or low O_2, levels which may develop around the fruit due to a change in respiration rates under fluctuating temperatures. Insertion of small holes into polymeric film bags has been shown to moderate CO_2 and O_2 fluctuations and may be a safer way of obtaining desired atmospheric conditions. However, information on influence of MAP on reduction of bitter pits in apple is inadequate (Hewett and Thompson, 1989). Therefore, the present study was carried out to examine the effect of MAP on bitter pit development and quality in Kashmir apples.

Physiologically mature fruits of 'Red Delicious' and 'Golden Delicious' apples were obtained from a private orchard of Shopion (Dist.- Pulwama, J&K) in the last week of September. Large and uniform sized fruits were surface-cleaned and packed in 25 µm thick polymeric film of 30 x 30 cm size. Various treatments of MAP comprised of polymeric film without perforation (T_1), polymeric film with 10 x 1 x 2 mm perforations (T_2), polymeric film with 10 x 2 x 2 mm perforations (T_3), and polymeric film with 10 x 3 x 2 mm perforations (T_4). Fruits without polymeric film packaging (T_5) served as the control. Each treatment with ten fruits was replicated five times. Packed fruits were kept in separate cardboard boxes and stored at ambient temperature (18^0C/12^0C). After four months of storage, observations were recorded on incidence of bitter pit and on other quality parameters. Fruit firmness and TSS were measured with penetrometer and hand refractometer, respectively. Acidity was determined following the procedure of Ranganna (1986). Data were statistically

[1]Directorate of Extension Education

Table 1. Effect of modified atmosphere packaging on quality parameters in apple cultivars

Treatment	PLW (%)	Fruit firmness (lbs)	T.S.S. (%)	Titrable acidity (%)
		'Golden Delicious'		
T_1	5.3	10.3	9.8	0.228
T_2	7.1	11.0	9.2	0.258
T_3	9.0	9.3	8.6	0.265
T_4	10.2	9.6	11.2	0.188
T_5	15.5	8.2	13.2	0.154
C.D *(P=0.05)*	0.5	0.5	0.6	0.038
		'Red Delicious'		
T_1	7.3	8.8	13.4	0.165
T_2	6.5	7.8	14.6	0.158
T_3	7.7	7.1	16.8	0.135
T_4	9.8	7.6	15.3	0.128
T_5	16.2	8.5	14.8	0.184
C.D *(P=0.05)*	0.7	0.4	0.8	NS

T_1 : without perforation; T_2 : 10 x 1 x 2mm perforation; T_3 : 10 x 2 x 2mm perforation; T_4 : 10 x 3 x 2mm perforation; T_5 : without polyethylene packaging.

analyzed using standard procedures (Gomez and Gomez, 1984).

Bitter pit incidence was higher in 'Golden Delicious' than in 'Red Delicious' apples (Table 1). Fruits packed in polymeric film containing perforations had significantly less bitter pit incidence than fruits in sealed polymeric film and without perforation polymeric film. The incidence was found to decrease with increasing number of perforations (Fig1). The incidence of the disorder in 'Golden Delicious' (15.1%) was the highest in T_1 treatment followed by T_5 (7.8%) and the least (1.8 %) in T_4. 'Red Delicious' apples also showed the highest incidence (3.7%) in T_1 followed by T_5 (2.7%) and the least incidence of bitter pit in T_3 (1.5 %), and T_4 (1.8%). Higher incidence of bitter pit in 'Golden Delicious' apples may be due to low levels of calcium in the fruits tissue as compared to 'Red Delicious' apples (Khan *et al*, 2006). 'Golden Delicious' apple has also been reported to be the most susceptible cultivar with reference to bitter pit development (Snowdon, 1990). Efficacy of perforated polymeric film in reducing the incidence of bitter pit has also been shown by Hewett and Thompson (1989) with 'Cox's Orange Pippina apples, On the contrary, fruit spoilage due to internal breakdown was significantly higher in 'Red Delicious' compared to 'Golden Delicious' apples (Fig 2). This may be attributed to accumulation of CO_2 in the intercellular spaces of the fruit, as, 'Red Delicious' apples have thicker skin than 'Golden Delicious' which may have hindered the diffusion of CO_2 from the fruit. A possible reason for the increased rate of spoilage in fruits stored in polymeric film with a smaller number of perforations may be accumulation of acetaldehyde, ethanol, malic acid and succinic acid. The activity of glycolytic and Krebs cycle enzymes is known to be inhibited by low levels of 02 leading to accumulation of CO_2 around the fruits (Parritt *et al*, 1982). It is also evident from table 1 that physiological loss of weight (PLW) increased with increasing number of perforations, and, fruits of both the cultivars packed in polymeric films without perforation exhibited minimum weight-loss compared to fruits stored without polymeric film packing. The physiological loss in weight is attributed chiefly to transpiration. Higher number of perforations in polymeric

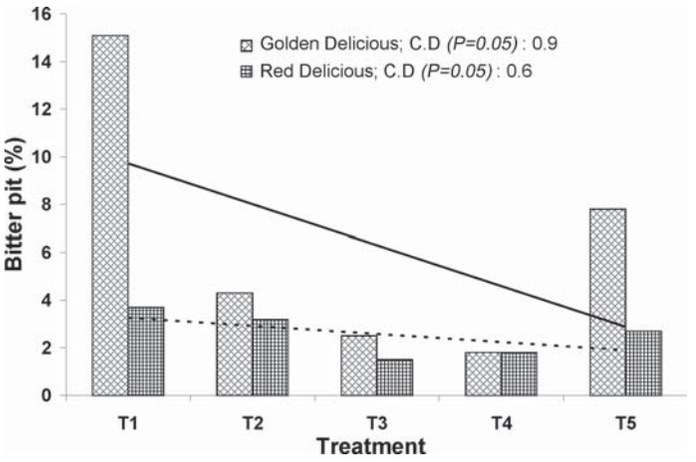

Fig 1. Effect of modified atmosphere packaging on bitter pit development in apple.

T_1 : without perforation; T_2 : 10 x 1 x 2mm perforation; T_3 : 10 x 2 x 2mm perforation; T_4 : 10 x 3 x 2mm perforation; T_5 : without polyethylene packaging.

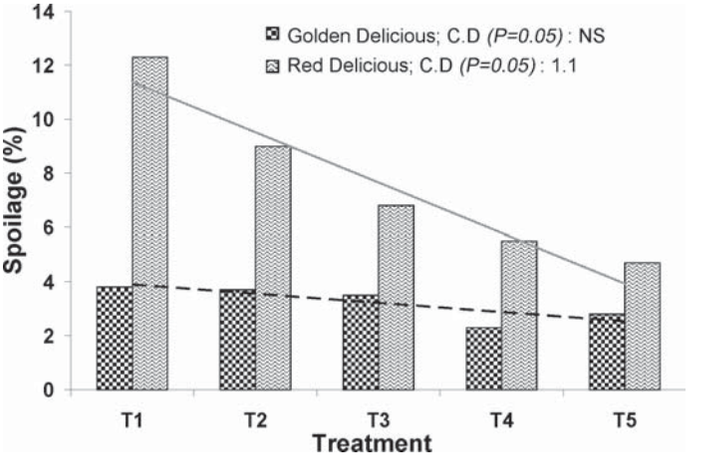

Fig 2. Effect of modified atmosphere packaging on fruit spoilage in apple.

T_1 : without perforation; T_2 : 10 x 1 x 2mm perforation; T_3 : 10 x 2 x 2mm perforation; T_4 : 10 x 3 x 2mm perforation; T_5 : without polyethylene packaging.

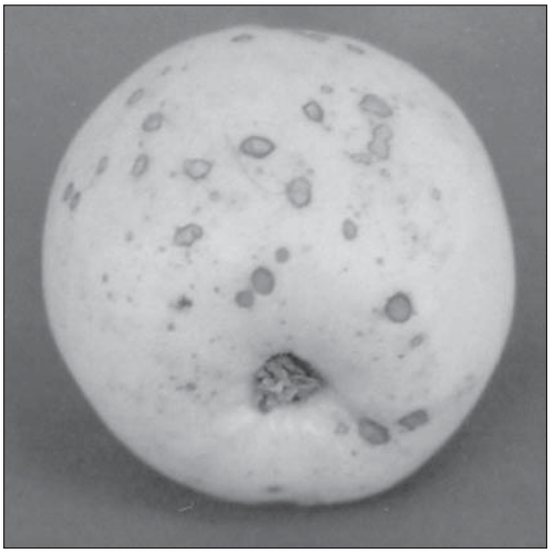

Plate 1. Bitter pit in Golden Delicious apple

films may have may increase VPD leading to higher transpiration and weight-loss. Fruit firmness decreased with increasing number of perforations whereas total soluble solids showed the opposite trend. Decrease in fruit firmness with increased perforation could be the result of enhanced activity of glycolytic and Krebs' cycle enzymes due to an increased level of oxygen in perforated polybags (Parritt *et al*, 1982; Mir and Beaudry, 2002). Greater water loss from the tissue may also be one of the reasons for decreased fruit firmness through decreased turgor pressure of cells. Increased TSS in better aerated packing may also be attributed to hydrolysis of complex food materials to simpler forms due to aerobic respiration and to concentration of the juice due to dehydration. Similarly, titrable acidity also differed significantly in 'Golden Delicious' apples but did not show marked variation in 'Red Delicious' with perforated polymeric films packing.

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