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A REVIEW ON PRESERVATION OF FRUITS BY SUCROSE POLYESTER COATINGS

SUKROZ POLİESTER KAPLAMA MADDESİ İLE MEYVELERİN KORUNMASI ÜZERİNE BİR DERLEME

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ABSTRACT: Quality preservation is considered to be the rajor factor in fresh fruit marketing. An efficient way to maintain the quality of fruits is the use of coatings. Sucrose polyesters is a recent advance in the field of coatings which function by reducing the internal levels for oxygen of fruits without a simultaneous increase in carbon dioxide levels. As a result of this modification a decrease in respiration rate and a delay in ripening of fruits take place. Other benefits derived from the use of sucrose polyesters are reduction of water loss, nutritive value loss and microbial growth. Sucrose polyesters have been tried on various fruits and shown to give promising results.

ÖZET: Kalitenin korunması taze meyvelerin pazarlanmasında önemli bir faktördür. Meyve kalitesinin korunması için kaplama maddesi kullanmak etkili bir yoldur. Kaplama maddeleri alanında yeni bir gelişme olan sukroz poliesterlerin etki mekanizması, meyve içindeki karbondioksiti artırmadan oksijeni azaltmaktır. Bu mekanizma ile solunum hızında yavaşlama ve olgunlaşmada geçikme olmaktadır. Sukroz polyester kaplama maddesi kullanmanın diğer faydaları ise meyvedeki su kaybının, besin kaybının ve mikrobiolojik büyümenin azaltılmasıdır. Sukroz poliester kaplama maddesi çeşitli meyveler üzerinde denenmiş ve gelecek vaadeden sonuçlar elde edilmiştir.

INTRODUCTION

Fruits continue their metabolic activity including respiration, also after harvest. The increase in ripening depends on respiration rate. During ripening and senescence various changes take place in the quality of fruits. Several changes occur in the cell wall composition and structure that result softening of fruits. Due to the breakdown of chlorophyll and synthesis of carotenoids, the colour of fruits change. Acid and sugar contents of fruits change. Volatiles which contribute to flavor and aroma may develop. Ethylene is one of the volatiles that is synthesized in certain fruits at certain stages of maturity and triggers the ripening process (SALUNKE et al., 1991). Due to all of these changes fruits lose their quality criteria, their resistance to mechanical and microbial disturbances quickly so they should be stored very carefully under specific conditions.

Coating is an efficient preservation technique to prolong the storage life of fruits even for the developing countries as it does not require high technology and is quite economical when compared to other preservation methods.

Sucrose polyester coatings is a recent advance in coating technology. At first, sucrose polyester catings are introduced as Prolong™ (TAL Chemicals Company, Reading; UK). It is a mixture of sucrose esters of fatty acids, carboxymethyl cellulose and mono-diglycerides of fatty acids (LOWINGS and CUTTS, 1982). Semperfresh™ is an improved formulation of earlier sucrose polyesters due to the higher proportion of short chain unsaturated fatty acids (DRAKE et al., 1987).

MAIN EFFECTS OF SUCROSE POLYESTER COATINGS

Optimum extension of post harvest life of fruits depends on three factors which are reduction in respiration, reduction in desiccation and reduction in the onset and rate of microbial growth (ERBİL and TEOMAN, 1985). Coating of fruite with sucrose polyesters is an efficient way to reduce these factors, especially the first two.

Reduction in Respiration

A gas transfer equilibrium is present between the fruit and the environment during respiration of fruits. When a fruit is coated the equilibrium is destroyed and depending on the surface area, thickness and permeability of coating a new gas transfer equilibrium is obtained (ERBİL and TEOMAN, 1985).

When oxygen permeability of coating is very low, respiration rate of fruit decreases. However coating should not completely inhibit the transfer of oxygen. When oxygen can not diffuse into the fruit, fermentation takes place which leads to the formation of alcohol and aldehydes (ERBİL and MÜFTİGİL, 1986).

Sucrose polyesters were stated to be effective in reduction of oxygen without an equivalent rise in concentration of carbon dioxide (LOWINGS and CUTTS, 1982). The reason for this is that sucrose molecule is hygroscopic and attracts water in the atmosphere which cause a water barrier to be established oxygen molecule moves very slowly through water and carbon dioxide is not trapped by the water barrier. The oxygen and carbon dioxide permeability of sucrose polyesters were reported as 800 ml.mil/m^2 day atm and 4500 ml.mil/m^2 day atm at 30 °C and 50 % RH respectively (HAGENMAIER and SHAW, 1992).

Sucrose polyester coatings were reported to reduce the internal oxygen level in the banana fruit but this reduction did not cause an increase in level of carbon dioxide as shown in Table 1 (BANKS, 1984).

Table 1. Effect of sucrose polyesters on the internal atmosphere of banana fruit after a storage period of 16h at 20°C

Coating	CO_2(%)	O_2(%)
-	5.33	12.74
+	1.78	1.23

It was also shown that internal oxygen level of banana were reduced by 85% with an increase in the level of carbon dioxide by 30% by means of sucrose polyesters (BANKS, 1983).

Concentration of sucrose polyesters is a significant factor for reduction of the respiration rate of fruits. Sucrose polyesters were shown to be effective for reduction of the respiration rate of "Ankara" pears at concentrations more than 0.5% as shown in Figure 1 (ŞÜMNÜ and BAYINDIRLI, 1994).

Sucrose polyesters at different concentrations reduced respiration rate of apricots (Figure 2). Concentrations of 1.0% and 1.5% were particularly effective. The effect of coatings is related to the reduction in the climacteric peak of respiration curve (ŞÜMNÜ and BAYINDIRLI, 1995a).

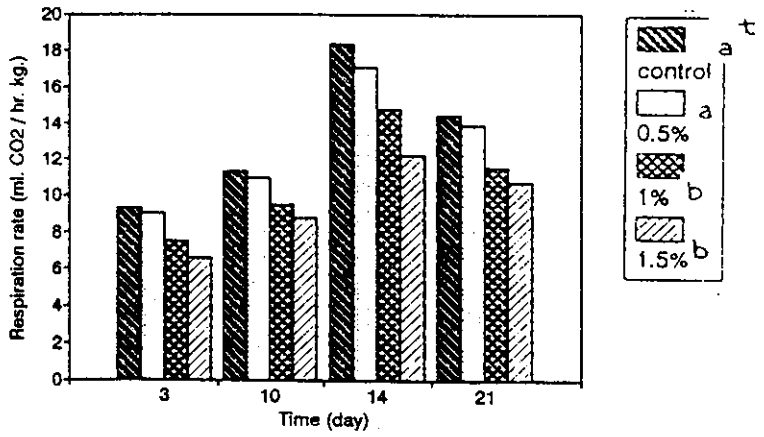

Figure 1. Effects of sucrose polyesters on respiration rate of pears

(t means concentrations followed by different letters are significantly different at p=0.05 by duncan's new multiple comparison method.)

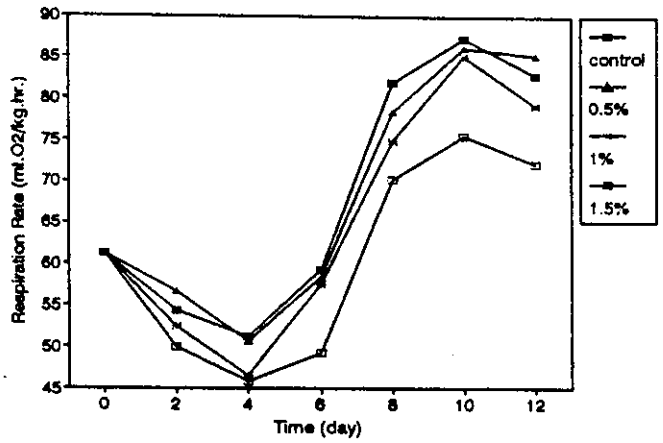

Figure 2. Effects of sucrose polyesters on respiration rate of apricots.

Modification of internal atmosphere by the use of coating becomes more extensive as temperature is raised. Table 2 shows the change of internal atmosphere of sucrose polyester coated apples due different storage temperatures (SMITH and STOW, 1984).

Table 2. Effects of sucrose polyesters on internal atmosphere of apples after 21 days.

Sucrose Ester (%)	Storage temperature (°C) 3.5		10		18	
	CO_2	O_2	CO_2	O_2	CO_2	O_2
0	0.98	18.00	1.51	17.82	2.94	18.21
1	1.67	17.50	3.28	16.62	4.83	16.41
2	1.89	17.30	4.58	15.72	5.70	14.97
3	3.74	16.04	4.70	14.90	8.94	10.24
4	4.16	14.90	6.76	11.52	9.90	10.73

Reduction in Desiccation

The mechanism of moisture loss from fruits is the same as evaporation of water. The driving force is the vapor pressure of moisture in the fruit. Amount of water loss will depend on type, size, composition, structure and temperature of fruit and temperature, relative humidity of the surrounding atmosphere (RYALL and PENTZER, 1985).

Sucrose polyesters were found to be not always effective to reduce the weight loss of fruits. The reason for the inefficiency of sucrose polyesters for reduction of weight loss is that sucrose polyesters have high water permeability compared to other commercial waxes (HAGENMAIER and SHAW, 1992). When Cox Orange Pippin apples were coated prestorage with sucrose esters, sucrose ester treatment did not reduce weight loss of fruit during cold storage. However sucrose ester application reduced weight loss in the fruit particularly at 18 °C (SMITH and STOW, 1984).

When apricots were coated at 0.5%, 1.0% and 1.5% concentration of sucrose polyesters and stored at ambient temperature with a relative humidity of 40%, concentrations of 1.0% and 1.5% were found to be more effective than 0.5% for reduction of weight loss. However during cold storage (0-1°C & 70% RH) all concentrations reduced weight loss to about the same extent (ŞÜMNÜ and BAYINDIRLI, 1995a). This can be explained by the high permeability of coatings at high relative humidity (HAGENMAIER and SHAW, 1992).

Reduction in the Rate of Microbial Growth

Waxes provide a carrier for fungicide so they are effective in reduction of decay of fruits. Even if fungicides are not added to the coating as the internal oxygen and carbon dioxide content of the fruit can be adjusted by the use of coatings, bacterial activity decreases (ERBİL and TEOMAN, 1985).

Sucrose polyesters were shown to be effective in increasing resistance of apples, pears and plums to some fungal rols of *Sclerontinia* species and *Rhizopus nigricans* (LOWINGS and CUTTS, 1982).

EFFECTS OF SUCROSE POLYESTERS ON QUALITY CRITERIA OF FRUITS

Fruit coatings are also effective in reduction of the rate of ethylene production colour, firmness, acid and sugar changes.

Effects on Ethylene Production

Ethylene permeability of coating is important for diffusion of gas into or out of the fruit. If ethylene permeability of the coating is low, ethylene will be diffused out of the fruit very slowly and accumulate in the fruit. This will increase the ripening of fruits. That's why coatings with high ethylene permeability such as coatings made from waxes with little shellac or rosin is desired (HAGENMAIER and SHAW, 1992).

Internal ethylene concentrations of apples was shown to be reduced by sucrose polyester coatings (DRAKE et al., 1987).

Effects of Coatings on Colour of Fruits

Sucrose polyesters were found to be effective for colour retention of apples (CHAI et al., 1991; DRAKE et al., 1987; SANTERRE, 1989; SMITH and STOW, 1984; ŞÜMNÜ and BAYINDIRLI, 1995b), pears (ŞÜMNÜ and BAYINDIRLI, 1994), bananas and plantain (ALZAEMEY et al., 1989; BANKS 1983; 1984) and apricots (ŞÜMNÜ and BAYINDIRLI, 1995a). The mechanism how coating is effective in retention of colour is not exactly known. It may be a result of direct effects of coatings on chlorophyll loss through interference with chlorophyll degradation processes or effects on chloroplast structure (SMITH et al., 1987).

In pears, sucrose polyesters of low concentrations were shown to be effective for delaying the development of yellow colour (DINAMARCA et al., 1989). However, especially high concentrations caused improper ripening of pears which was detected by a blotchy appearance or uneven green yellow discoloration (MEHERIUK and LAU, 1988; VAN ZYL et al., 1987; ŞÜMNÜ and BAYINDIRLI, 1994).

Effects on Firmness of Fruits

Sucrose polyesters were shown to be effective in reduction of softening of apples, pears, bananas, apricots and plums (ALZAEMEY et al., 1989; CHAI et al., 1991; DINAMARCA, 1989; DRAKE et al., 1987; MEHERIUK and LAU, 1988; ŞÜMNÜ and BAYINDIRLI, 1994; 1995a; 1995b).

Effects of Coatings on Sugar and Acid content of Fruits

The acidity loss during ripening of fruits is attributed to the activities of malic and carboxylase enzymes which are associated in respiration. The longer retention of acidity of coated fruits may be due to the effects of coatings on reduction of respiration rate (SMITH et al., 1987). Sucrose polyester coatings were shown to be effective for retention of titratable acidity of fruits (DHALLA and HANSON, 1988; DRAKE et al., 1987; MEHERIUK and LAU, 1988; ŞÜMNÜ and BAYINDIRLI, 1995a; 1995b; BAYINDIRLI et al., 1995). However the time of application of sucrose polyesters is important for reduction of acidity change. When fruits are coated after they are matured, the sucrose polyesters has no effect on acid loss (SANTERRE et al., 1989, ŞÜMNÜ and BAYINDIRLI, 1995b; VAN ZYL et al., 1987).

The rate of increase of total sugars was reduced due to the application of coatings on bananas (BANKS, 1985; LOWINGS and CUTTS, 1982).

Effects on Vitamins

After harvest ascorbic acid oxidase enzyme oxicizes ascorbic acid to dehydro ascorbic acid (SCHIMID, 1969).

Sucrose polyesters were found to be effective to reduce the rate of ascorbic acid loss of pears of variety "Ankara". The effects of coating on ascorbic acid retention is that it reduces the oxygen transfer into the fruit so ascorbic acid is reduced (ŞÜMNÜ and BAYINDIRLI, 1994). The efficiency of sucrose polyesters on reduction of ascorbic acid loss is also shown on mangos, apricots and tangerines (DHALLA and HANSON, 1988; ŞÜMNÜ and BAYINDIRLI, 1995b; BAYINDIRLI and ŞÜMNÜ, 1995).

EFFECTS OF SUCROSE POLYESTERS ON FLAVOR OF FRUITS

Coatings have both beneficial and adverse effects on flavor of fruits. Coated fruits have better flavor compared to uncoated ones as there is more retention of acids, sugars and flavor constituents due to the delay of ripening. Howover, when coatings reduce the oxygen transfer into the fruit extremely, off flavor takes place due to the formation of alcohols and acetaldehydes (ERBİL AND MÜFTİGİL, 1986).

Sucrose polyester coatings were shown to have no adverse effects on flavor of fruits. Flavor of sucrose ester treated apples and bananas were not found significantly different than uncoated ones (ALZAEMEY et al., 1989; CHAI et al., 1991; SANTERRE et al., 1989). However especially high concentrations of sucrose polyesteres may lead off flavors (DHAILA and HANSON, 1988).

CONCLUSION

Sucrose polyester coatings can be an alternative to other preservation methods especially in the developing countries as they are shown to be effective for maintaining quality factors of fruits such as firmness, colour, flavor and ascorbic acid. However concentration of sucrose polyesters is a significant factor for quality retention of fruits. Each fruit and variety need different concentrations. Many studies were made to find the optimum concentration of coatings for well known varieties of fruits but studies should continue to find the optimum concentration of sucrose polyesters for other varieties of fruits in the world.

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