EFFECT OF SEMPERFRESH ON POSTHARVEST BEHAVIOR OF CUCUMBER (*Cucumis sativus* L.) AND SUMMER SQUASH (*Cucurbita pepo* L.) FRUITS

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Abstract

Cucumber and summer squash fruits were tested to investigate the effect of polymer fruit coating material Semperfresh on postharvest quality. Semperfresh is applied to the already washed fruits by dipping method at 0.8% and 1.0% doses, and allowed to dry at room temperature. Storage experiments carried out at 12°C and 90-95% RH in cold room. Respiration rates and external quality of fruits were also studied during shelf life at 20°C.

Results of two cucumber varieties (Niz 760, Hana) and one summer squash variety (Arlica) were nearly similar. Semperfresh did not retard water loss during storage on Arlica variety of summer squash and Niz 760 cucumber variety. However, 1.0% application of Semperfresh is commercially important in reducing the water loss of Hana cucumber variety. Semperfresh applications significantly reduced respiration rates of fruits. Moreover, coated fruits were greener in skin color than non-coated fruits stored at 12°C. Especially reduced rates of respiration and chlorophyll degradation were more evident in the 1.0% dose of Semperfresh. Variations in external quality between coated and non-coated fruits were visually important. Semperfresh coated fruits had increased marketable characteristics. These are observable in slower color change, decreased respiration rate and slow softening. Semperfresh can be beneficial for cucumber and summer squash at 1% dose for limited storage and shelf life.

Keywords : Cucumber, summer squash, postharvest, semperfresh

1. Introduction

Postharvest losses observed on fruit and vegetables through the 'cold chain' are obviously related with lack of know-how, technology and the social structure of the people. The rate of such losses however, can be reduced to acceptable values if some measures are taken before and during the storage. Application of fruit coatings is known to reduce some postharvest problems quite economically (Özelkök and Kaynas,1991). The most important factor in the storage is to prevent water loss which actually accounts nearly for all the weight loss of fruit and vegetables. Water loss, on the other hand, is a surface phenomenon and closely related to physical structure of the product and evaporative efficiency of the storage air. Among the physical features of the product; density of lenticels, amount of stomates and their structure, and of the storage air; storage temperature, relative humidity, air movement and packaging related vapor pressure deficit (VPD) are very important (Ryall and Lipton,1983). The majority of the water loss takes place through stomates and cutin layer which are under the control of epidermis. Several esters, waxes and wax polymers and fatty acids are involved in the control mechanism. Additionally, organic substances such as paraffin keton-like aliphatic polymers having hydrocarbon structures are also involved either singly or together (Akamine et al.,1975; Ben-Yehoshua,1987). The general purpose of using fruit coating materials is to prevent water loss and shriveling. Besides, these substances are known to contribute to the integrity of the product and increase their marketing appeal. On the other hand, pre-storage applications of fruit coatings can be incorporated with fungicides so as to prevent storage rotting (Ryall and Lipton,1983). Precautions should be taken as to the physiology and structure of product when coating applications are intended. The material chosen has to cover the entire surface and not to interfere with the surface gas exchange mechanism. Otherwise, this may cause alcohol fermentation as the metabolism shifts to anaerobic pathway. Another important step in the use of coatings is related to the public health. Substances should be safe for human consumption and not to be toxic, chemically stable and have the ability to dry out quickly (Ben Yehoshua,1987). In general, fruit coatings have found wide applications especially on citrus fruits and particularly on apples as wax emulsions. In recent years, commercial fruit coating applications on vegetables have been increasingly gaining importance.

Semperfresh (SMF) is the trade name for family of fruit coatings all based on the concept of total safety in use. All these fruit coatings have the ability to delay the rate at which fruit ripens or matures thus prolonging its edible life. Within the semperfresh range there are coatings specially formulated to suit any particular type of fruit. All SMF fruit coatings are mixtures of three basic ingredients. These are: - mixed sucrose esters of fatty acids, - sodium carboxymethylcellulose, - mixed mono-diglycerides of fatty acids.

Sucrose esters are compounds of sucrose and fatty acids derived from edible fats and oils. Since sucrose has a total of 8 hydroxyl groups, compounds ranging from sucrose mono fatty acid esters can be produced. It is the sucrose esters in SMF which enable the product to delay the ripening of crops. Sodium carboxymethylcellulose is the ingredient in semperfresh enabling a coherent film to be formed and to cling to the surface of the crops. The mixed mono-diglycerides of fatty acids in SMF act as emulsifiers to ensure an even dispersion of the coating in water. SMF works by restricting the rate at 0_2 can pass across the skin of fresh fruit into the interior without at the same time restricting the passage of other gases. By reducing 0_2 level within the tissue of the fruit, metabolic processes are slowed and the fruit ripens more slowly. SMF by coating the outside of each fruit effectively converts each fruit into a self CA store. Since the passage outwards of $C0_2$ is not restricted there is a little danger of anaerobic conditions being established inside the fruit as a result of the coating (Anonymous, 1989).

According to the results of studies in which SMF has been used as coating for fresh fruit and vegetables; gas exchange on bananas was reported to be slowed down, but ethylene production not affected (Al-Zaemey et al.,1990), ripening was delayed for 4-5 days on bananas as well (Marchal et al.,1987), senescence was prevented to some extent on pears and plums (Dinamarca et al.,1990), delayed ripening of apples resulted from reduced rates of internal ethylene production and overall respiration (Drake et al.,1988), prevention of chlorophyll breakdown and subsequent softening, increased acid/sugar ratio have also been reported (Özelkök et al.1992), SMF however, did not reduce water loss but lowered the quality especially the flavor if storage is extended. Softening of tomatoes during marketing was delayed and one more week of gain was reported to be feasible (Flores,1988). Studies on tomatoes, eggplant, green pepper and stuffing green peppers as well as on artichokes indicated the slowed down of respiration and chlorophyll degradation (Kaynas et al.,1992).

2. Material and methods

In the study conducted at ATATÜRK Central Horticultural Research Institute cucumber varieties; Niz 760 and Hana, and summer squash variety Arlica grown in a non-heated greenhouse were used. Applications of SMF was performed by dipping method at concentrations of 0.8% and 1.0%. Fruits were dried in air and subsequently stored at 12^{0}C and 90-95%RH. Every application was replicated 3 times and 25 fruits were included in each replication. Storage limited to 21 days for cucumbers and 14 days for summer squash and weight loss (%), chlorophyll contents (Holden,1979) were determined by weekly and their respiratory behaviors were followed (Claypool and Keefer,1942) at 20^{0}C. Fruits were evaluated on the basis of their appearance, whitering, and senescence and grouped into (1: bad, ..3: marketable,..5: excellent).

3. Results and discussion

Figure 1 shows chlorophyll changes on skin of fruits held at 12^{0}C for 21 days storage. In both cucumber varieties and at two doses the reduction of chlorophyll began immediately with the storage. The rate especially was eminent after 7 days. Reduction of chlorophyll was found to occur at slower rates on SMF treated fruits compare to controls, and Hana variety was more affected than Niz 760. On Niz 760, 29.60μ/cm^2 total chlorophyll value at pre-storage lessened to 15.01μ/cm^2 after 21 days on non-coated fruits whereas at 16.12μ/cm^2 at fruit received 0.8% SMF and 16.68μ/cm^2 in 1.0% SMF treatment. Respectively, on Hana variety, the figures found after storage were 11.12μ/cm^2, 16.68μ/cm^2 and 20.85μ/cm^2 compared to 26.82μ/cm^2 pre-storage initial. Thus, the retained chlorophyll content by SMF at 1.0% on Hana variety at the end of storage period was 90% more compared to controls. When expressed as chlorophyll a and b the changes were more or less similar. The positive effect of SMF on Hana variety was obtained by 1.0% application. Fruit yellowing as observed on non-coated fruit after 7 days storage, on the other hand, it was observed in treated ones after 20 days storage. Rate of chlorophyll loss on summer squash was even more dramatic on nontreated fruits after 14 days storage. The loss was only 15% of the initial material in 1.0% SMF treatment whereas it was 50% in uncoated fruits. Such a beneficial effect of fruit coatings can be expected in applications (Ben-Yehoshua,1987). Similar effects have also been reported to occur in pears and plums (Dinamarca et al.,1990), apples and pears (Özelkök et al.,1992), in cucumber (Eris and Türk,1990) and many fruit-vegetables (Kaynas et al.,1992).

The weight loss increased with increase in storage time finalizing at 20-25% on cucumbers and 15% on summer squash after 21 in the former and 14 days of storage period in the latter. While both SMF applications on Niz 760 cucumber and 1.0% on Arlica did not affect the weight loss, 1.0% SMF treatment, significantly yielded reduced water loss ($P<0.01$) on Hana variety. In 0.8% SMF treatment, weight loss had significant percentage (24.5%) as did the controls but, the rate was found to be 19.1% on 1.0% SMF treated ones. Application of SMF at both doses did not affect weight loss significantly on summer squash variety Arlica during 14 days of storage.

SMF treatment was found to significantly reduce the respiration rate of fruits at 20°C. Continuously measured for 12 days, the average respiration rate of Niz 760 cucumber variety was curtailed from 50-70 mgCO_2/kg-hr in nontreated fruits down to 35 mgCO_2/kg-hr at 0.8% and 40 mgCO_2/kg-hr at 1.0% dose of SMF. Although the rates of both doses were nearly equal, the respiration rate was much lower in Hana. Starting at 45 mgCO_2/kg-hr initially the rate gradually diminished to 10 mgCO_2/kg-hr at 20°C. Those which received SMF treatment showed a steady rate of 12 mgCO_2/kg-hr. On Arlica, no difference was observed between treated and nontreated fruit during the first 5 days of shelf life at 20°C, but while the respiration rate slowed down, thereafter it increased in the controls (Figure 2). SMF's marked reducing effect on the respiration rate of fruit can be explained by its restrictive role on the diffusion of O_2 through the surface where it clings as a layer and elevated CO_2 of the medium as a result from the emission of the gas by the fruits (Anonymous,1989; Drake et al.,1988; Van-zyl and Wagner,1986). Such mode of action was explained by Al-Zaemey et al.(1989) on bananas in a way that SMF might cause to form modified atmosphere layer on the skin surface of fruits so that the partial pressures of O_2 and CO_2 are significantly deviated.

Postharvest quality losses of cucumbers and squash result from skin color fading and shriveling. SMF played an important role in the restoration of color, reduction of weight loss and diminished respiration rate. While treated and nontreated cucumbers retained their quality parameters during the first 7 days of storage, those fruits that were left untreated, noticeably detracted from marketable quality. SMF coated fruits were still marketably in the end of 14 days. The treatment was not effective afterwards regardless of the dosage (Figure 3).

In conclusion, 3-4 days of prolonged storage by SMF treatment is feasible on cucumber whose storage potential is already limited to 7-10 days. On squash on the other hand, maximum 5-7 days storage period could be extended to 7-10 days by SMF.

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Table 1. The effect of semperfresh treatments on weight loss of stored cucumber and summer squash fruits at 12^{0}C

Variety	Doses	Storage (days)			Mean of doses
		7	14	21	
	0.0%	10.34	16.80	25.84	17.66
NIZ 760	0.8%	8.96	16.96	20.59	15.50
	1.0%	10.35	16.59	22.27	16.40
Mean of storage days		9.88 **c**	16.78 **b**	22.90 **a**	
	0.0%	9.70	17.00	24.03	16.91 **a**
HANA	0.8%	10.62	18.32	24.51	17.82 **a**
	1.0%	8.60	14.57	19.10	14.09 **b**
Mean of storage days		9.64 **c**	16.63 **b**	22.55 **a**	
	0.0%	6.38	18.21		12.30
ARLICA	0.8%	6.07	12.61		9.34
	1.0%	6.66	16.03		11.35
Mean of storage days		6.37 **b**	15.62 **a**		

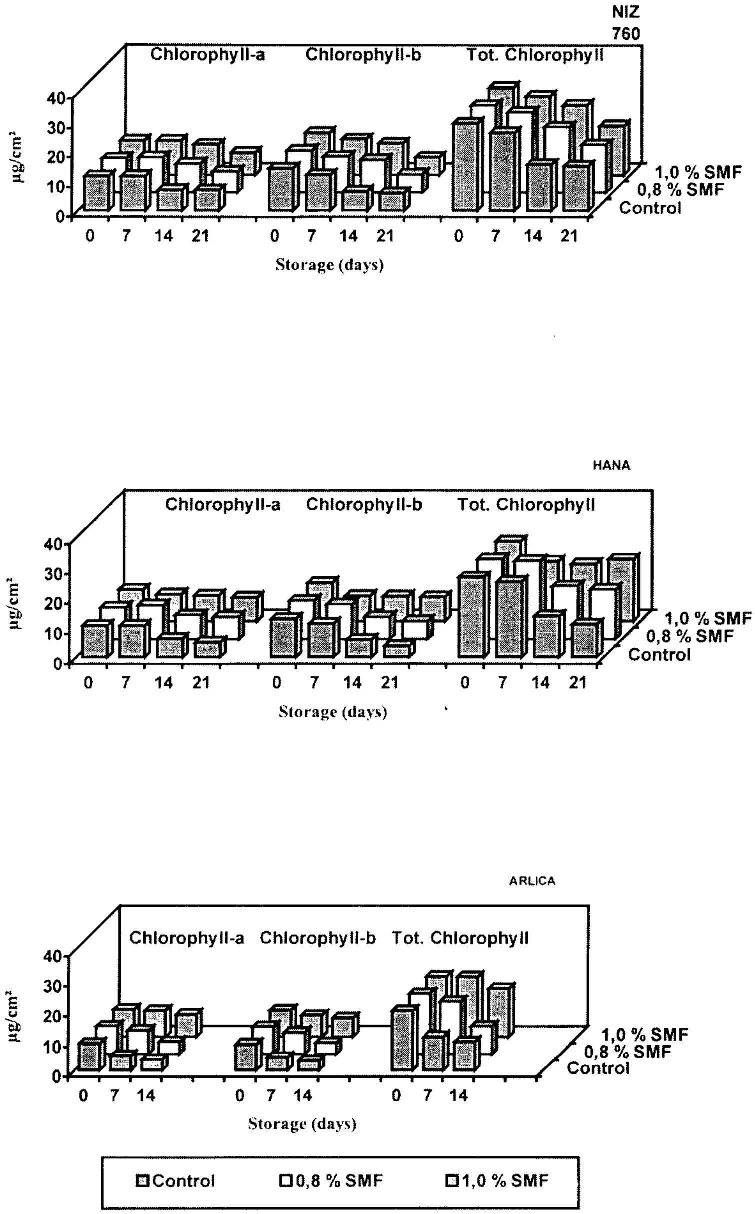

Figure 1. Effect of Semperfresh treatments on chlorophyll content of cucumber and summer squash varieties during storage at 12°C

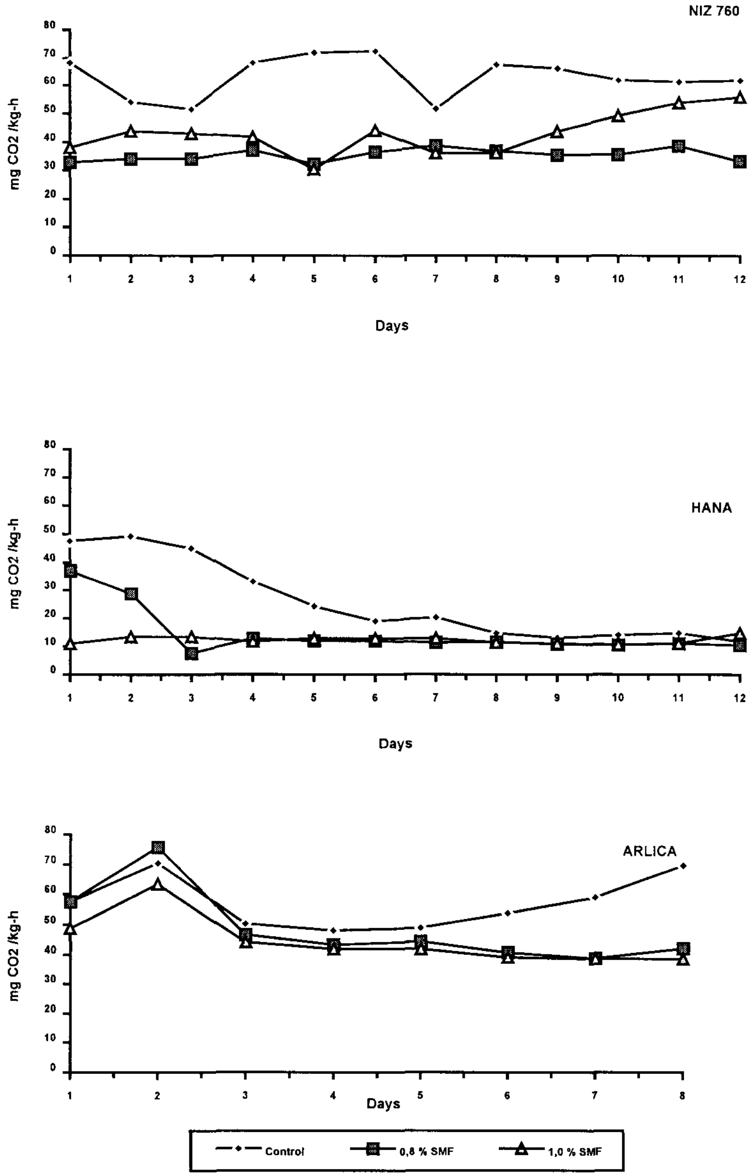

Figure 2. Effect of Semperfresh treatments on respiration rates of cucumber and summer squash fruits at 20^{0}C

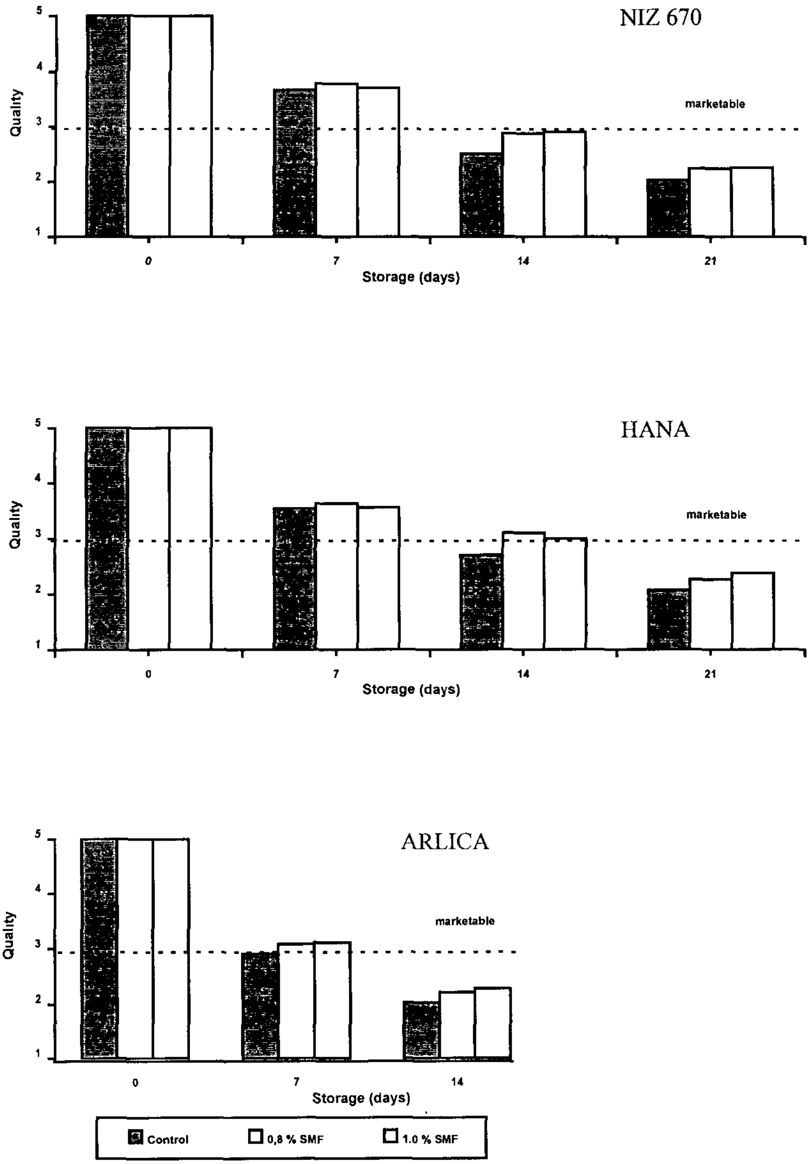

Figure 3. Effect of Semperfresh treatments on quality of cucumber and summer squash fruits during storage at 12^{0}C