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A. Testoni
Istituto Sperimentale per la Valorizzazione Tecnologica dei Prodotti Agricoli,
Via Giacomo Venezian 26, 20133 Milano, Italy
E-mail: testoni.ivtpa@interbusiness.it

SUMMARY – In the last few years the interest for persimmon cultivation has increased in the Mediterranean area, both for the favourable trend of the market and for the ease of adaptability to the Mediterranean climate. Moreover, the compounds having nutraceutical effects have increased the consumers' interest for this fruit. The main nutraceutical compounds are carotenoids, tannins and fibre, active in the prevention of chronic-degenerative diseases, and they have antiradical and antibacterial activity. The trend and concentration of soluble tannins in the astringent and non-astringent fruits are illustrated; astringent removal methods in tannin types are shown and discussed. Special emphasis is given to the astringency removal method based on high CO_2 treatments, giving edible fruits with good firmness and crispiness. Experiments on 'Hachiya' and 'Hiratanenashi' have shown that the astringency removal with CO_2 is obtained in one day after treatments versus the five or seven days necessary, with Ethanol vapours or N_2, respectively. Aspects of ripening and softening, technology of natural ripening (with heat) and artificial ripening (with heat and ethylene) and the effects of growth regulators like GA_3, ABA, CEPA, PBZ and 1-MCP are also considered. The main storage technologies are illustrated as well as the operating parameters (temperatures about 0-2°C and RH about 85-90% and maximum length of storage, about two or three months) in regular storage or in controlled atmosphere (temperatures –0.5-2°C, O_2 level between 6-15%, and CO_2 level between 10-15%). Finally, the possibilities of processing fruit are illustrated.

Key words: Nutritional compounds, astringency, ripening, growth regulators, harvest indexes, storage conditions, processing.

RESUME – *"Post-récolte et conditionnement des plaquemines". Depuis quelques années l'intérêt pour la culture du kaki a renouvelé son importance dans les pays méditerranéens soit pour les perspectives favorables du marché soit pour la rusticité et la faculté d'adaptation de cette culture au climat méditerranéen. De plus, il faut considérer aussi l'intérêt des consommateurs envers ces fruits riches en composés à finalité nutritionnelle comme les caroténoïdes, les tannins et les fibres qui préviennent les maladies chroniques et ont des effets bactéricides et antiradicaliques. La variabilité et les concentrations des tannins solubles ont été illustrées dans les fruits astringents et non astringents et les techniques d'élimination de l'astringence des types tanniques ont été considérées ; une importance particulière a été donnée à la technique fondée sur les traitements qui utilisent une concentration élevée de* CO_2 *et permettent d'obtenir des fruits très consistants et croquants. Les expériences conduites sur 'Hachiya' et 'Hiratanenashi' ont montré que l'élimination de l'astringence est obtenue avec un jour après le traitement avec* CO_2 *contre 5 ou 7 jours nécessaires respectivement avec vapeurs d'éthanol ou* N_2*. Dans cette note ont été considérés aussi les aspects de la maturation et de l'attendrissement des fruits en utilisant soit des méthodes naturelles (chaleur) soit des méthodes artificielles (chaleur et éthylène) et les effets des hormones comme* GA_3*, ABA, CEPA, PBZ et de l'1-MCP. En ce qui concerne la conservation des fruits, les principales technologies et les plus importants paramètres opérationnels utilisés (température environ 0-2°C, humidité relative environ 85-90% et durée maximale de conservation 2 ou 3 mois) avec réfrigération ou avec l'emploi de l'atmosphère contrôlée (températures -0,5-2°C, niveau* O_2 *entre 6-15% et niveau* CO_2 *entre 10-15%) ont été illustrés. Enfin, la potentialité à la transformation industrielle des fruits a été soulignée brièvement.*

Mots-clés : *Composés à finalité nutritionnelle, astringence, maturation, hormones, indices de cueillette, technologies de conservation, transformation industrielle.*

Composition and nutraceutical aspect

The persimmon is a highly nutritional fruit (Itoo, 1971) containing carotenoids, vitamin C, tannins, pectic substances and high levels of sugars.

The main compounds are:

(i) Total sugars. The average is 14-18 g/100 g fresh weight; the main sugars are fructose and glucose (90% of the total) and with a ratio 1 to 1. Sucrose (that normally disappears at full maturity), galactose and arabinose are present as minor components.

(ii) Pectins. The total amount of pectic substances range from 0.7 to 1% fresh weight. The pectic substances are divided into three groups: water-soluble about 65%, oxalate soluble about 10% and insoluble pectins about 30%.

(iii) Soluble tannins. The amount of soluble tannins ranges from 0 to 4% fresh weight on the basis of the cultivar, and of the ripening stage. The main component of persimmon tannins is a leucodelphinidin 3 glucoside named "diaspyrin"; minor components are leucocyanid, gallic acid, gallocatechin and gallocatechin gallate.

(iv) Carotenoids. The total amount ranges between 5 and 6 mg/100 g fresh weight, while in the peel of mature fruit the amount is 10 times higher. The composition of pigments reveals that β-cryptoxanthin and lycopene are the major components, respectively, 31% and 20-30% of the total β-carotene is also present in small amounts.

(v) Vitamin C. Persimmon is a good source of ascorbic acid about 50 mg/100 g fresh pulp. The immature fruit and peel contain considerably more ascorbic acid than the pulp of mature fruit.

(vi) Aminoacids. Nineteen aminoacids are identified in the flesh; citrullin is the main component. The amino nitrogen is about 15 mg/100 g fresh weight.

Apart from the nutritional aspects, the persimmon can be seen as an interesting nutraceutical fruit because of its high amount of carotenoids and polyphenols. The principal carotenoids present in human plasma are betacarotene, lycopene and beta-cryptoxanthin and these are only available from food and they are particularly known for their antioxidant power; they regulate the activity of lipo-oxygenase, which is responsible for the production of pro-inflammatory molecules. Up to now little is known about beta-cryptoxanthin while more and more research is being made on lycopene and beta-carotene.

As for tannins, it is known they have a protective role against free radicals. Research on rats has shown that the protective effect is 20 times higher than vitamin E, and tannins can help lengthen the lives of hypersensitive rats or those with heart diseases. There have been suggestions that persimmons are also beneficial in reducing high blood pressure and that they have antibacterial effects.

Persimmon astringency and removal

Persimmon fruit can be classified into four groups, depending on their astringency at the ripening harvest and the pollination effect, i.e. the presence or not of seeds in the flesh (Bellini and Giannelli, 1982; Itoo, 1986).

The Pollination Constant Not Astringent (PCNA) group is not astringent both with or without seeds.

The Pollination Variant Not Astringent (PVNA) group is not astringent at harvest if the fruit has seeds.

The Pollination Constant Astringent (PCA) group is always astringent.

The Pollination Variant Astringent (PVA) group is astringent also if pollinated. They are not astringent only around the seeds and have dark tannin spots.

Figures 1 and 2 show the trend of some parameters for cv. 'Hiratanenashi' (PCA) and cv. 'Jiro' (PCNA). For both cultivars the trend of fruit diameter is represented by the double sigmoid (Fig. 3) while the colour increase of the skin is almost regular starting from the end of August-beginning of September.

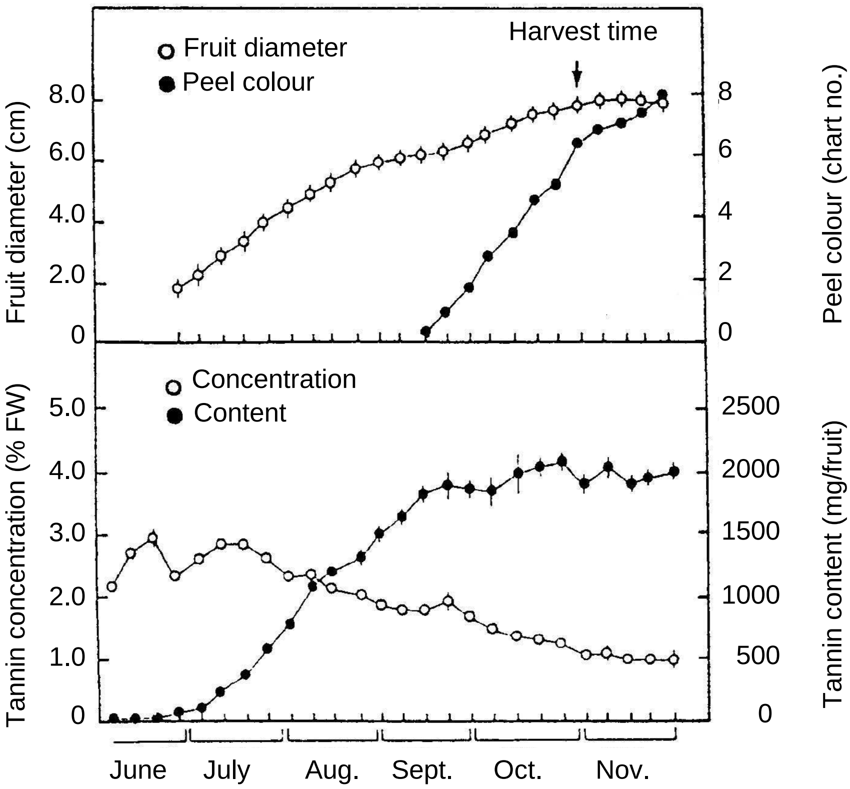

Fig. 1. Changes in fruit diameter, peel colour and soluble tannins of the flesh during fruit development in 'Hiratanenashi' (Taira, 1996).

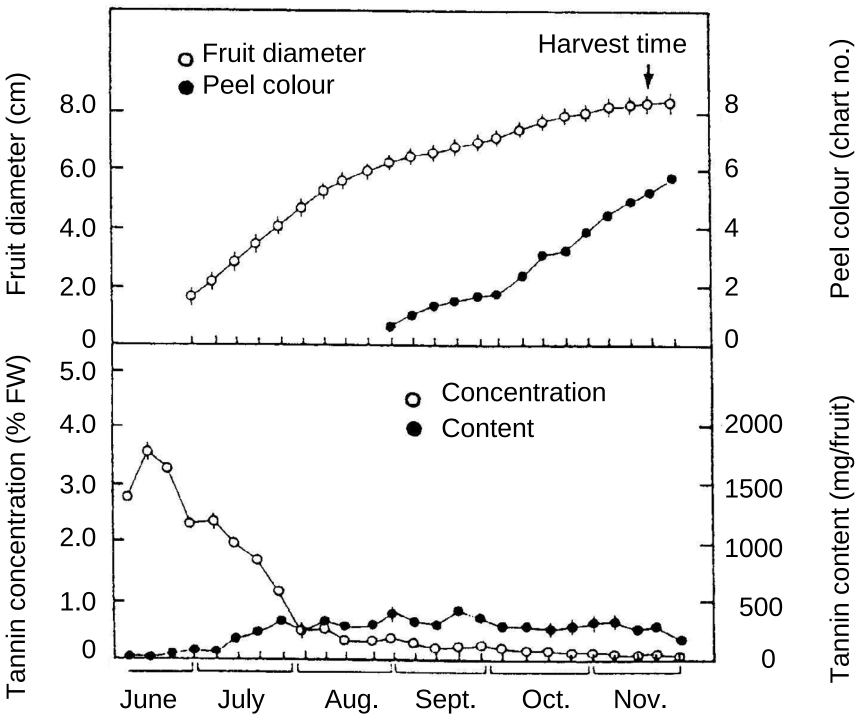

Fig. 2. Changes in fruit diameter, peel colour and soluble tannins of the flesh during fruit development in 'Jiro' (Taira, 1996).

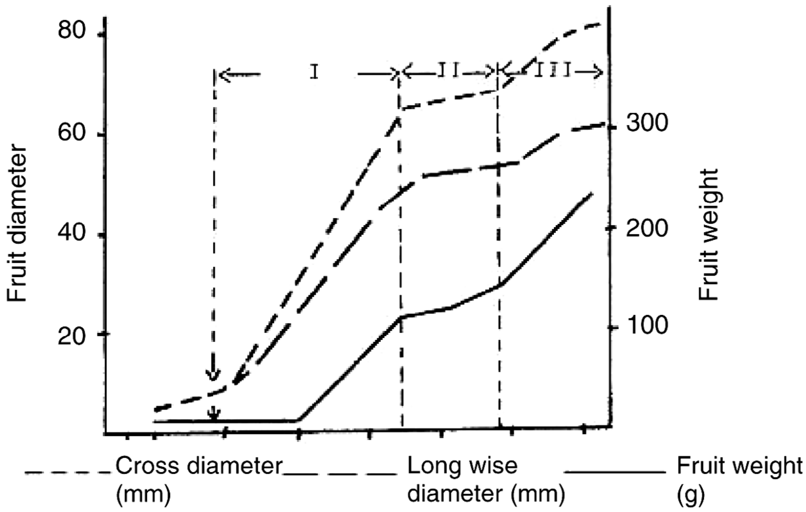

Fig. 3. Changes in fruit diameter and weight of non-astringent fruit during development in stages I, II and III (Itoo, 1986).

The soluble tannin concentration in 'Hiratanenashi' gradually diminishes reaching 1% at harvest at the end of October. The soluble tannin concentration in 'Jiro' decreases much more quickly already at the end of July to 1% and then disappears at harvest half way through November.

The astringency sensation of persimmon comes from the presence of soluble tannins that are grouped together in large cells named "tannin cells". When these cells are broken by a bite during eating, they release soluble tannins that interact with protein on the surface of the tongue, producing the astringency sensation. During the ripening process (softening) or during astringency removal treatments, soluble tannins coagulate and become insoluble and they are not noticed anymore (Matsuo and Itoo, 1978).

The most frequently used technique to measure the soluble tannins is the Folin-Denis method (Taira, 1996) but there is an easier method called "Tannin print method" (Eaks, 1967) where a solution of ferric-chloride at 5% reacts on the cut surface of the fruit after an immersion of 30 s and produces an ion complex tannin-Fe of blue-black colour; the intensity of the colour is correlated with the soluble tannins content and this colour is evaluated on a scale of 1 to 9.

Many methods exist for astringency removal, among them alcohol treatment, freezing, CO_2 treatment, ripening and softening. These methods are based on the acetaldehyde action which occurs in the fruit during the process. Figure 4 shows the trend of total and soluble tannins in the cv. 'Hiratanenashi' (Taira *et al.*, 1990) treated after harvesting with ethanol vapours at 15% at 20°C or with 80% of CO_2 at 20°C. The soluble tannin decreases during treatment and fruits are not astringent after seven days of the alcohol treatment and three days of the CO_2 treatment.

Zavrtanik *et al.* (1999) in research on 'Hachiya' and 'Fuyu' cvs, treated the persimmons with CO_2 and N_2 at 99.9% for 24 h at 20°C, then stored the fruits at 1°C, and found that the total polyphenol concentration (Fig. 5) decreased very quickly and fruits were edible after one day of the CO_2 treatment; N_2 treatment reduced polyphenol content less quickly and fruits were edible after five to seven days while those under control treatment lost polyphenols slowly and were edible after 10 days of storage. In this research the authors found no internal browning after N_2 treatment, however, this occurred with the CO_2 treatment as was found by Testoni and di Tonno (1988) in a previous research on the cv. 'Kaki Tipo'.

In this latter study the fruit was treated with CO_2 at 60% for five days or at 90% for three days at 10°C and stored at 10 or 20°C. At 10°C the fruit showed less browning than at 20°C. Shimomura and Subhadrabandhu (1997) proposed a rapid astringency removal system by which the removal was achieved by treatment of 0.62-2.5 ml of 99.5% ethanol/kg fresh fruit and above 95% CO_2 for 3-5 h at 40°C. The author suggested a sealed incubation of 12 h at 40°C after a temporary opening and chemical removing, and the fruits were stored at 20°C. The treated fruits remained unripe and had a "crisp" texture for a long period.

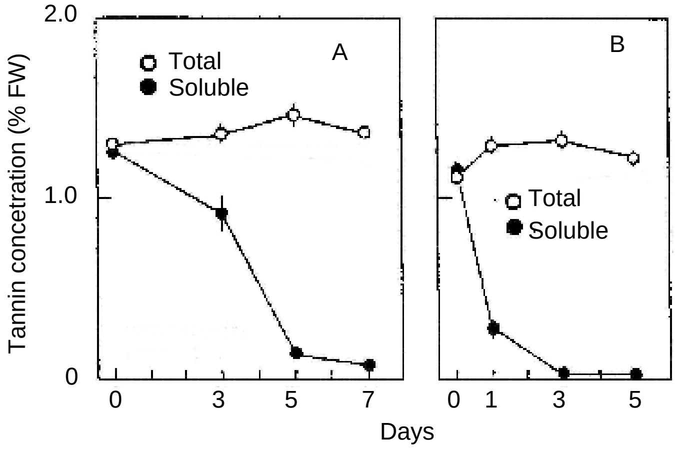

Fig. 4. Changes in soluble and total tannins during post-harvest treatments for removal of astrigency in 'Hiratanenashi'. (A) Ethanol vapour treatment. (B) Carbon dioxide gas treatment (Taira *et al.*, 1990).

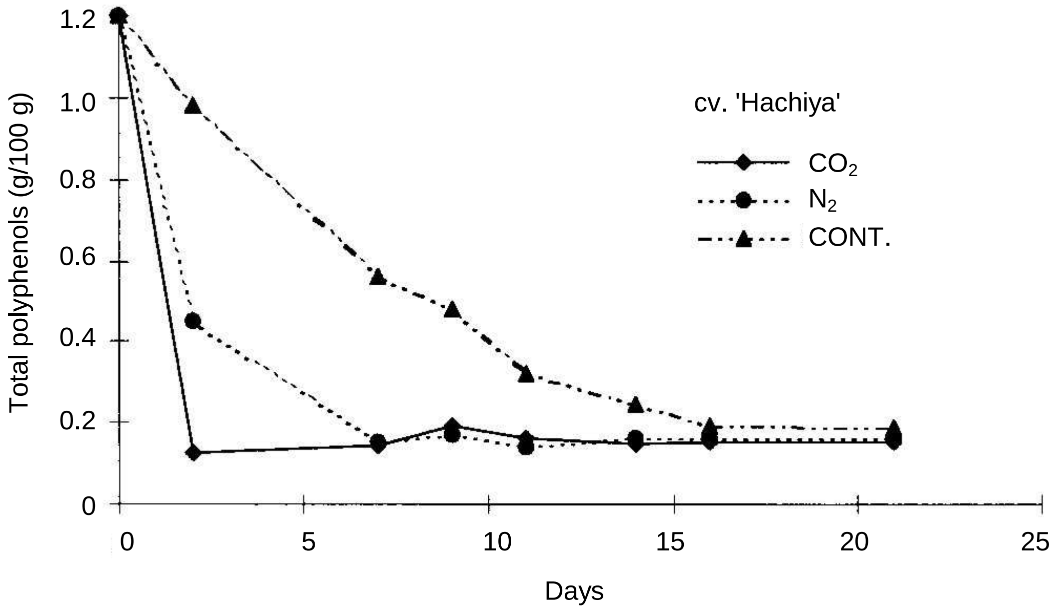

Fig. 5. Total polyphenol concentration in 'Hachiya' persimmon after treatment at 20°C for one day and during storage at 1°C (Zavrtanik *et al.*, 1999).

Ripening and growth regulators

Growth regulators can be used in persimmons, like other fruits, to delay or accelerate growth and ripening. Treatments with gibberellic acid (GA_3), (Kitagawa *et al.*, 1966; Ben Arie *et al.*, 1986), sprayed on branches 10 days before the arranged harvesting, are able to delay fruit growth and chlorophyll degradation (degreening) and carotenoids development. The effects of these treatments are delayed harvest, better fruit firmness, good storability and better quality after storage.

Ben Arie *et al.* (1996) studied the effects of GA_3 on the metabolism of the cell walls in cv. 'Triumph' and found a delaying action or inhibition of the changes (softening) that occur during ripening. They found less degradation of middle lamella, separation of plasmalemma of cell walls, less loss of neutral sugars, decreasing of enzyme activity, exopolygalacturonase and endo1,4 beta-glucanase. The GA_3-

treated fruit showed a higher content of total carbohydrates in the cell walls due to the higher amount of cellulose both at harvest, and after storage in comparison to the control (Fig. 6). Normally treatments with GA_3 are made 10-15 days before harvesting using 50/100 mg/l of product, but it would seem more efficient to carry out multiple treatments; 30, 20, 10 days before harvesting using reduced doses, e.g. 20 mg/l (Perez *et al.*, 1995). The authors found in such treated fruit less decay caused by black spot disease. First, because the calyx remains erect till harvest, thus creating environmental conditions less suitable for the spread of the black spot. Second, because the GA_3 spraying reduces the ability of this fungus to produce the 1,4 beta-glucanase enzyme during the colonization under the calyx (Eshel *et al.*, 2000). Also Nakano *et al.* (1997) found that repeated treatments between stages II and III drastically reduced the respiration rate, delayed the growth of fruit diameter and maintained higher fruit firmness (Figs 7, 8 and 9).

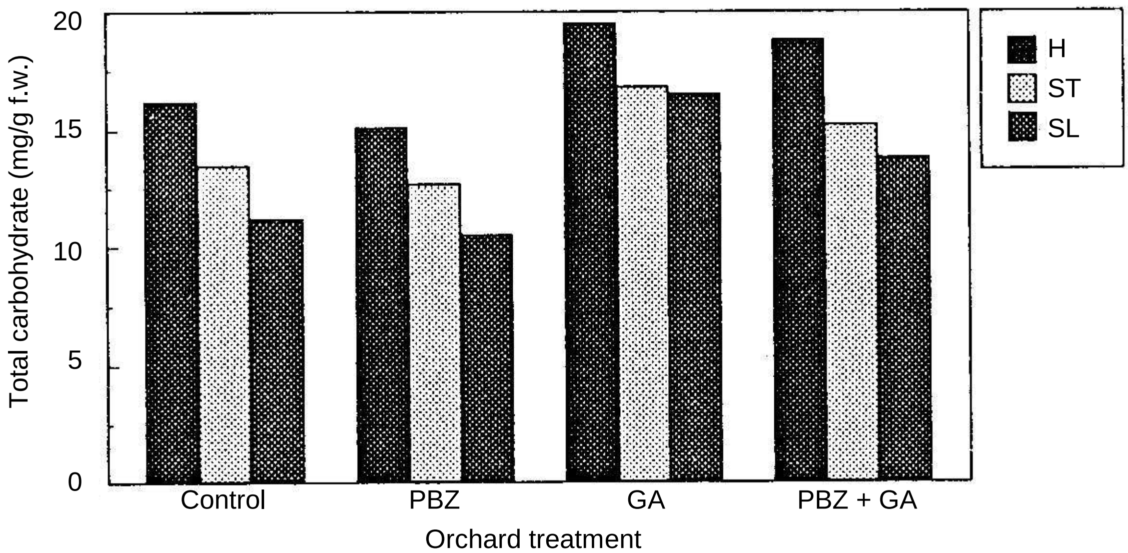

Fig. 6. The effect of orchard applications of PBZ (2 g/tree) and GA_3 (50 mg/l) on the total cell wall carbohydrates in persimmon fruits at harvest (H), after eight weeks at –1°C (ST) and five days at 20°C (SL) (Ben Arie *et al.*, 1997).

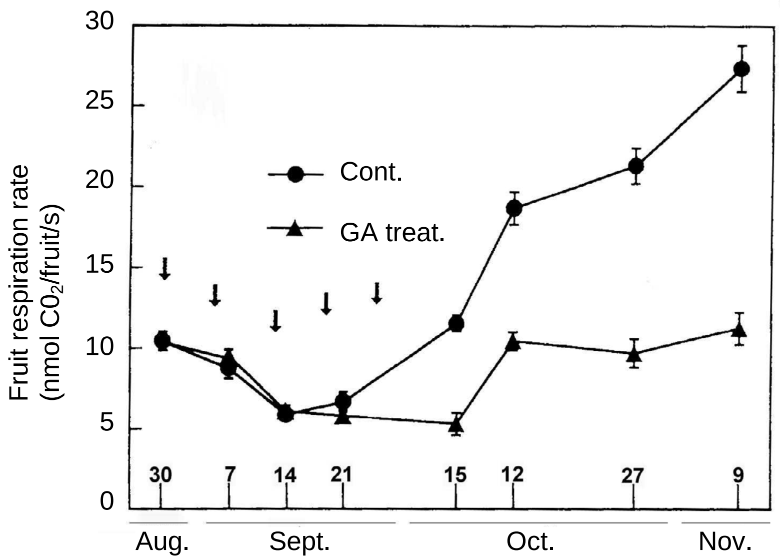

Fig. 7. Changes in fruit respiration rate affected by Gibberellic Acid (GA) treatment. Arrows indicate the dates when GA treatments took place (Nakano *et al.*, 1997).

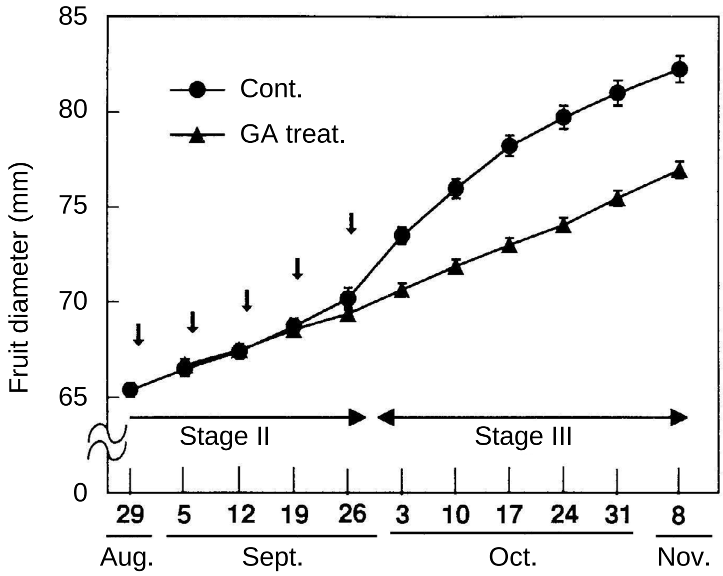

Fig. 8. Effect of Gibberellic Acid (GA) treatment on fruit growth of persimmon. Arrows indicate the dates when GA treatments took place (Nakano *et al.*, 1997).

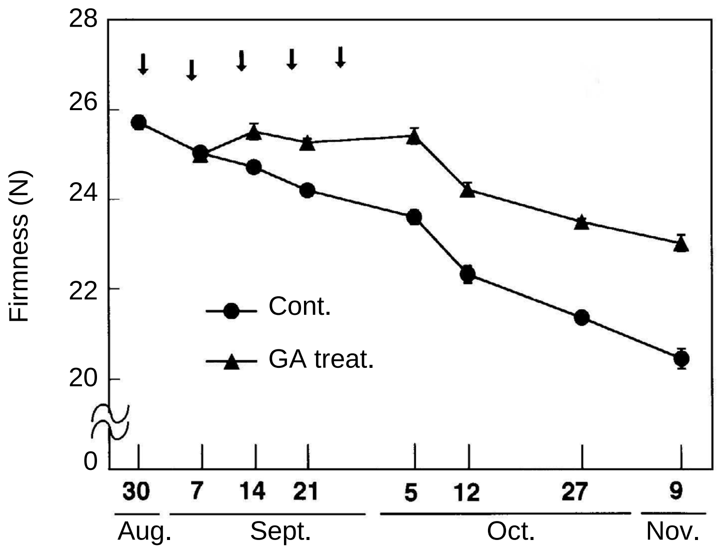

Fig. 9. Changes in fruit firmness affected by Gibberellic Acid (GA) treatment. Arrows indicate the dates when GA treatments took place (Nakano *et al.*, 1997).

A new product (1-MCP) has recently been used on many fruits including apples, pears and peaches to delay senescense. The product, used in post-harvest at low doses, is able to inactivate the ethylene receptors and to prolong shelf life.

Pre-treated CO_2 persimmon cv. 'Rojo Brillante' was treated post-harvest with 375 or 750 ppb of 1-MCP for 12 h (Salvador *et al.*, this volume). The results were the slowing down of respiratory metabolism, pulp softening and even a slower colour evolution; this could open a new scene for 1-MCP treatment on fruit suitable for long storage.

There are other growth regulator products such as abscisic acid (ABA), 2-ethylphosphonic acid (Ethephon; CEPA) and paclobutrazol (PBZ), that accelerate ripening and have an antagonistic effect on gibberellin. These products can be used alone or together with gibberellin to delay or accelerate ripening as required. The experimental treatments of Nakano *et al.* (1997) on single fruits of 'Hiratanenashi' using ABA in alcohol solution of 50% at doses of 100 or 250 ppm were able to increase fruit diameter and mainly induced an early fruit redness (Fig. 10).

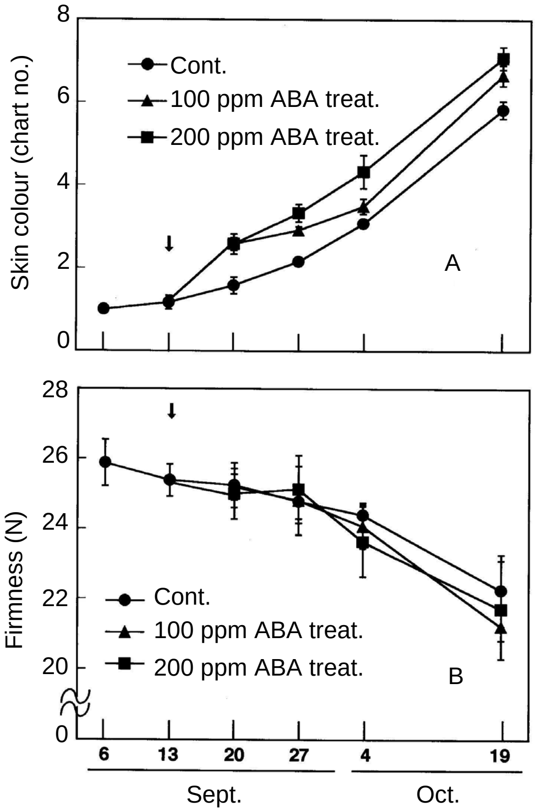

Fig. 10. Changes in fruit colour (A) and fruit firmness (B) affected by Abscisic Acid (ABA) treatment. Arrow indicates the dates when ABA treatments took place (Nakano *et al.*, 1997).

The higher the doses, the greater the diameter size and colour enhancement, while the treatments had no significant effects on fruit firmness or on the sugar composition. The ABA treatments were able to induce higher fruit respiration with a peak at least one week before that of the control (Fig. 11).

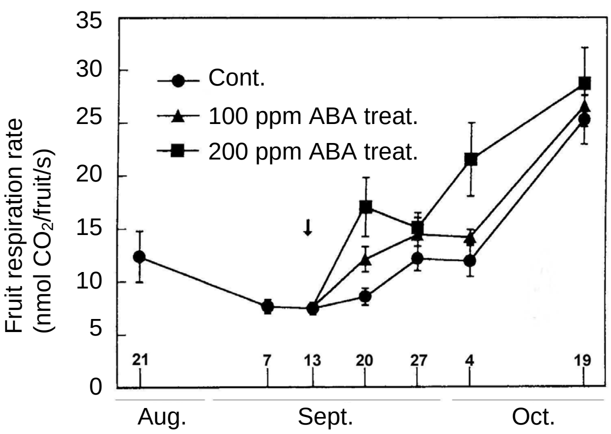

Fig. 11. Changes in fruit respiration rates affected by Abscisic Acid (ABA) treatment. Arrow indicates the dates when ABA treatments took place (Nakano *et al.*, 1997).

Also CEPA treatment is able to enhance harvest time, producing an earlier fruit colouring. The suggested doses (Monzini and Gorini, 1982) are between 10 and 30 mg/l and should be applied when the fruit colour is turning, i.e. when the fruit passes from the IInd to IIIrd stage of development. Japanese researchers have shown that early treatment in August has no effect on ripening and early coloration. CEPA treatment causes a better and homogeneous fruit colour and a quicker ripening with better organoleptic characteristics (Testoni and Sozzi, 1979).

PBZ, an inhibitor of gibberellin biosynthesis, can speed up the ripening process (Flohr *et al.*, 1993) by two to three weeks. There is no negative effect on fruit diameter when the compound is sprayed on the roots of the persimmon with a dose of 2 g/tree diluted in 2 l of water. Applications are carried out between May and mid June and fruits are as firm and coloured as the control. The concentration of the dose used can influence the colour enhancement (Ben Arie *et al.*, 1997; Fig. 12). On the other hand, the PBZ treatment reduced the storability by about four weeks and during the shelf life the fruit quickly loses its firmness and is more susceptible to decay (Fig. 13). The authors in their research have shown that by combining treatment with GA_3 15 days before harvest, these negative aspects were reduced.

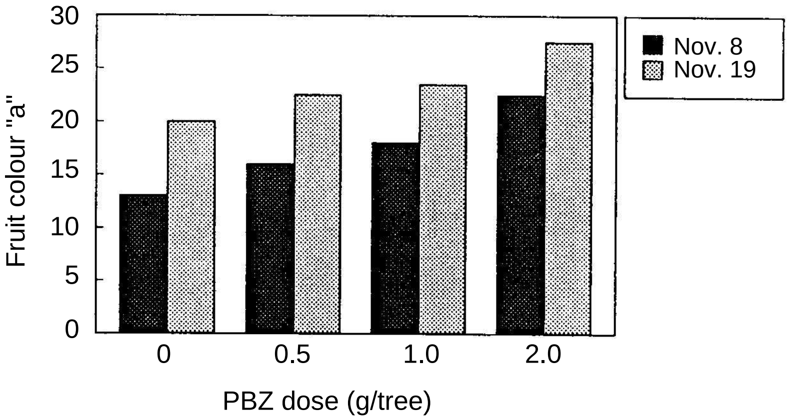

Fig. 12. The effect of dosage of PBZ spring application on fruit ground colour at two harvest dates (Ben Arie *et al.*, 1997).

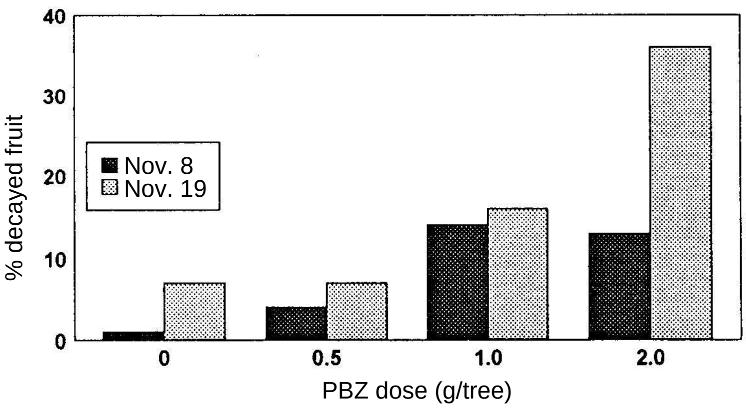

Fig. 13. The effect of dosage of PBZ spring application on the incidence of decay on fruit from two harvest dates stored for two months at –1°C and five days at 20°C (Ben Arie *et al.*, 1997).

Ripening and harvest indexes

Persimmons should be harvested when they are still firm but at a physiological maturity stage, meaning that the fruit has reached its turning colour and typical flavours have already been formed. This harvest time is identified at the end of stage III (Fig. 3) when fruit growth has concluded. In Italy this occurs in the second half of October and beginning of November for the most widely cultivated variety, 'Kaki Tipo'.

Concerning the background colour, it must be without chlorophyll and with a shade of yellow or orange. In Japan they have created colour charts for the most important cultivars indicating the minimum colour at harvest (Suzuki *et al.*, 1981).

New applications of fluorescence could be applied in the sorting of fruit by colour, thus creating homogeneous groups of fruit, each one destined for different maturation methods. The fluorimeter is able to measure the intensity and activity of chlorophyll, allowing the fruit to be divided into two or three classes from low, medium and high levels of chlorophyll.

It is very important to have physiologically homogeneous fruit at harvest for the next step of maturation. The correct temperature for softening and colouring depends on the low, medium and high levels of chlorophyll, e.g. the lower the chlorophyll the higher the temperature. The typical orange colour of persimmons, with new formation of lycopene in great amounts (about 30% of total carotenoids) is obtained only if the fruit is harvested at a correct maturation stage. It is known that if the harvest is made too early, the maturation is irregular and fruit colour is pale orange with yellow discolouring. Kitagawa and Glucina (1984) have studied the relationship between early harvesting and maturation temperature, measuring the fruit colour (by charts) after softening. They discovered that early harvested fruit treated at 25°C developed the same colour as fruit harvested 10 days later and maturated at lower temperature (15°C) (Fig. 14).

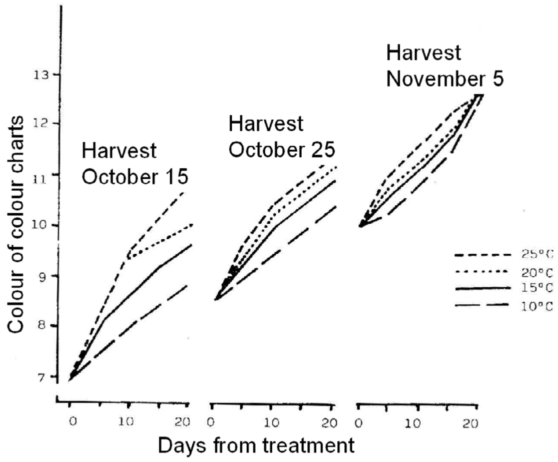

Fig. 14. Temperature effect on ground colour of the fruits cv. 'Fuyu' after different harvests (Kitagawa and Glucina, 1984).

Firmness cannot be considered a reliable maturity index since over 12 days of harvesting (Testoni *et al.*, 1981) the decrease is very slight (4.2 kg vs 4.0 kg). During softening there is a greater change in firmness in astringent varieties than in non-astringent ones (i.e. 'Fuyu').

A more interesting maturity index could be the soluble solids content because there is a significant increase of soluble solids between the two harvesting dates (about 2°Bx), and this difference is maintained after 80 days of storage at 0°C.

Natural and accelerated ripening

We can define natural ripening as the action of temperature on softening; we talk about accelerated ripening when, in addition to the use of temperature, there is an addition of external ethylene. Natural ripening is suitable for the non-astringent cultivars or for the astringent ones stored for a good period. Fruits are kept at about 20°C for 24 to 48 h or at lower temperature for 48-72 h. In this way the fruits are ready to be sold, but they are still quite firm so they can be transported and the maturation process continues during the retailing process.

Accelerated maturation includes all the ethylene producing substances (CEPA, etc.). In this way the respiration rate is speeded up, changing soluble tannins to insoluble, and softening the pulp.

The most common method consists of putting the fruit in hermetically-closed storage rooms, increasing the O_2 level up to 35-50% of the volume, adding a mixture of ethylene in Nitrogen about 1-2% and maintaining the temperature between 25-29°C for about 24-36 h. This depends on the maturity stage of the fruit (mainly colour). In the second step the temperature is lowered to 15°C and the fruits are kept until the desired colour is achieved, which is normally two or three days depending on the ethylene concentration used (Eaks, 1967; Reid, 1975). During this treatment, some problems may arise as the tissues soften and there is an increase of cellular turgor leading to cracking of the epidermis, therefore making the fruit unsaleable. Pratella *et al*. (1978) proposed maintaining a low humidity level (60-65%) during the softening stage, meaning that the fruit had higher weight loss during the treatment, but less cracking occurred. The aim of this accelerated process is to obtain a quicker fruit ripening yet balancing the astringency removal, softening and colour enhancement so the fruit can still retain certain firmness for retailing.

Storage

Persimmon is a subtropical plant so it has some problems at low temperature storage like other subtropical fruit. The medium-long period of storage is only two to three months at a temperature of 0-2°C and with RH 85-90% because there are two limiting factors: cold damage and mould caused by *Alternaria alternata*.

Generally not astringent and early ripening cultivars are less suitable to storage than the astringent and late ripening ones. The colour of persimmon slowly evolves during storage and sometimes it can become brownish, a sign of cold damage (Gorini and Testoni, 1988). This damage is related to the too early ripening stage when they have not reached the turning stage of colour. In fact green/yellow fruit can show cold damage even at 3-4°C; therefore the less coloured the fruit, the higher the storage temperature must be and the shorter the storage time. Research made in Italy has shown that fruit picked at the correct ripening stage could be stored for 60 days without loss of quality or decay. Among the cultivars tested 'Hana Fuyu' was the most suitable non astringent one while 'Hachiya', 'Licopersicon', 'Sakoumiathan', 'Amankaki' and 'Kaki Tipo' were the best among the astringent ones.

Many studies have been carried out on controlled atmosphere to try to lengthen the storage time: different atmosphere for different periods of time with different cultivars (Tanaka *et al*., 1971; Ben Arie and Blumenfeld, 1987; Mitcham *et al*., 1997; Park, 1997; Brackmann *et al*., 1999; Lee *et al*., 2000; Brackmann and Donazzolo, 2001).

Many authors have studied the non-astringent cv. 'Fuyu' up to 28 weeks of storage. They found severe rates of skin blackening (Fig. 15) already at eight weeks of storage at 0°C. Best results were obtained using the controlled atmosphere (CA) 6% of O_2 and 10% of CO_2. Also 4% O_2 and 10% CO_2 was interesting for its maintenance of flesh firmness (Fig. 16), Brackman *et al*. (1999) also used 'Fuyu' in their studies on different CA up to 15% O_2 and 15% CO_2 for 100 days storing at negative temperatures (–0.5; –1). The fruit retained higher flesh firmness even after four days of shelf life at 14°C, less decay due to black spots and lower percentage of skin-blackening compared to the CA, 2% of O_2 and 3% of CO_2. Also Lee *et al*. (2000) in their studies on different CA, still with 'Fuyu' stored for four months at 0°C, found different types of skin or flesh damage, coming to the conclusion that damage was caused by low levels of O_2 and not by high levels of CO_2. However more research is needed to find the right CA atmosphere that can be utilized on an industrial scale. At the moment the only industrial application of CA storage (1.5% O_2 and CO_2) at –1°C for three to four months is being made in Israel on the cv. 'Triumph'.

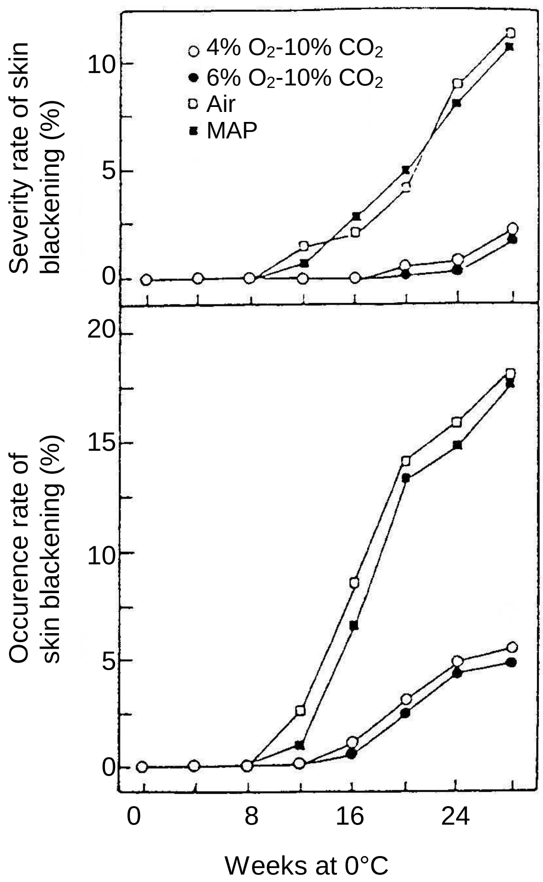

Fig. 15. Changes in occurrence and severity rate of skin blackening in non-astringent 'Fuyu' persimmon fruits by controlled atmosphere storage and modified atmosphere packaging (Park, 1997).

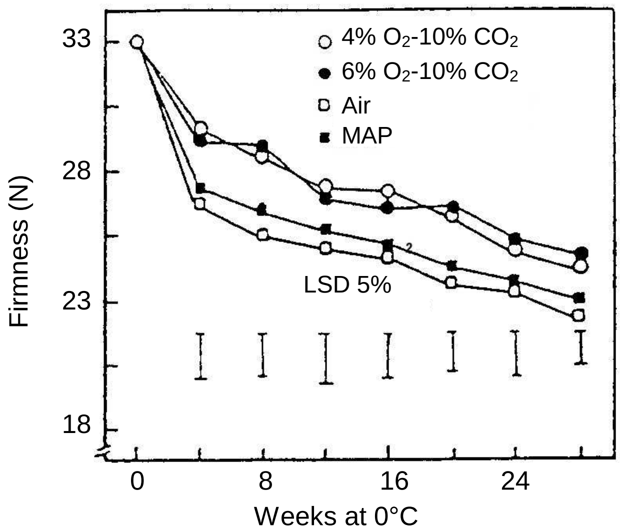

Fig. 16. Changes in flesh firmness of non-astringent 'Fuyu' persimmon fruits by controlled atmosphere storage and modified atmosphere packaging (Park, 1997).

Processing

It is difficult to obtain a processed product from persimmon owing to its mushiness when ripe and its chemical composition. Although rich in sugars (16-20%) and ideal for jam, persimmon fruit has few organic acids about (0.1%). This could be overcome by adding acidity correctors but the high content of water soluble pectins and tannins which are more or less soluble, make the concentration step difficult and could lead to an off-taste, or even browning of the jam with a loss of the typical persimmon aroma.

However there has never been a great demand for persimmon jam in the international market; tiny amounts are made locally only in some areas. Only in the US market is there a frozen puree to be used as a basis for the ice cream and cake industry. The most suitable variety in this field is 'Hachya', but the fruit must be completely ripe and not astringent. In Japan they have made a fermentation of fruit, as the persimmon has a high sugar content, obtaining an alcoholic drink (8% of alcohol) which is not acceptable to the European taste. The following step was the distillation of this type of wine but even this was not appreciated in western countries.

Another use, again in Japan, is the dried and powdered tannin juice with proteins added to clarify the traditional sake.

The most interesting industrial use of persimmons is the drying technique. In fact traditionally the Japanese and Chinese have always peeled, cut and sun dried persimmons. This process has been updated in California and in Italy, studying the technological cycle of oven drying and the ratio between time and temperature. In Italy (Testoni and Maltini, 1978) the ideal parameters were proposed for drying (hot air at 45°C for about 18 h) in relation to the ripening stage and thickness of slices of 'Kaki Tipo' persimmon. If the fruit is quartered and peeled the usable temperature is about 65°C. The final step is reached when the weight loss is about 75-85% of initial weight, obtaining a high-energy intermediate moisture product, ready to eat.

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