POSTHARVEST BEHAVIOUR OF FIVE SARDINIAN PRUNE VARIETIES AS AFFECTED BY IMMERSION IN HEATED SODIUM BICARBONATE SOLUTION

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ABSTRACT

Storage behaviour of 'Core', 'Core Columbu', 'Fradis' and 'Meloni' white prunes, and a black one ('Sighera') of Sardinian germplasm were evaluated following immersion for 0 (control), 15, 30, 45 or 60 sec in water at 20, 50, 55 or 60°C with or without 2% (w/v) $NaHCO_3$ (SBC). As international varieties, fruit from one white plum ('Shiro') and one black prune ('Stanly') were subjected to the same treatments. Fruit was harvested at commercial maturity, treated and then stored for 1 month at 5°C and 90% RH followed by a simulated marketing period at 20°C and 80% RH for 6 days. Fruit appearance, external damage, firmness and decay percentage were monitored after storage and SMP. Treatments did not induce rind damage (browning or discoloration) to any variety. SBC at 20, 45, 50 or 55°C for 15 or 30 sec was not effective in controlling decay and compared to controls no improvement was observed. Immersion for 45 or 60 sec with SBC at all temperatures improved decay control with respect to controls and best results were obtained at 50 or 55°C. Immersions at 60°C improved decay control, but differences were not significant compared to the control attained with solutions of SBC heated at 55°C. The overall appearance of 'Core', 'Core Columbu', 'Fradis' and 'Shiro' decreased significantly after the SMP period, especially when treated at 55 or 60°C for 60 sec. Fruit shrivel was the main cause of the low rating. SBC did not affect shrivel indicating that heat treatment may be the probable cause. In general, local varieties were less affected by decay than other varieties and they performed well during storage.

Key words: postharvest, GRAS compounds, plum germoplasm, *Botrytis cinerea*.

INTRODUCTION

Among stone fruits, plums (*Prunus salicina*) and prunes (*Prunus domestica* L.) are the most resistant to postharvest molds, even thought decay may become a considerable problem when fruit is harvested mature and/or when it is subjected to cold storage. In order to reach a high quality standard, stone fruit must be harvested when a outstanding concentrations of soluble solids is reached. This quality parameter cannot be improved after harvest but only maintained, thus, harvest must be performed as close as possible to fruit maturity (Crisosto and Kader, 2000). This implies several harvest and postharvest handling attention in order to prevent damages to the fruit rind. Injuries are among the entry point for postharvest pathogens such as *Monilinia fruticola* (Wint.) Honey, the cause of stone fruit brown rot. Even though, this pathogen infects also unwounded fruit, Corbin (1963) evidenced that the length of the median incubation period of this pathogen is significantly reduced when pathogenesis starts into wounds and a much lower inoculum dosage is needed, especially when fruit is mature. In addition, decay susceptibility was found to change significantly among cultivars, and Lee and Bostock (2007) suggested that differences among specific phenolic compounds in the fruit exocarp may be the reason of the wide range of natural resistance against brown rot. *M. fruticola* is

e cause of the major postharvest disease of stone fruit worldwide and its control ust be programmed from early on in the orchard. Thus, an appropriate manage-ent during the preharvest period is likely to provide fruit with a low level of inoc-um. Still, this strategy is not satisfactory to control postharvest losses especially hen wet springs occur. Thus, postharvest treatments are fundamental to contain e spread of brown rot. Recently, two "reduced-risk" fungicides, fludioxonil and nhexamid, have been shown to be more effective in controlling brown rot of one fruit than the largely employed iprodione (Förster *et al.*, 2007). Still, these vo fungicides are not registered for postharvest application to stone fruits in all oducing areas. In addition, several countries avoid to import stone fruits when sidues of any chemical are detected in the fruit (Karabulut and Baykal, 2004). As r other commodities, researches have been addressed to find alternative post-ırvest treatments to synthetic fungicides and/or integrated approaches to reduce e use of pesticides (Margosan *et al.*, 1997; Karabulut *et al.*, 2002; Palou *et al.*,)09). Several methods have attained satisfactory control of decay during the ɔstharvest stage, but up to date, alternative protocols have not accomplished the dustry needs in terms of efficacy and cost. The most promising results were at-ined when fruit was immersed or drenched with heated water or solutions of food ldditives. Stone fruit was shown to withstand temperatures as high as 55 and 60°C r up to 60 sec without effects on fruit quality (Palou *et al.*, 2009). Heating a lutions of 200 mM of potassium sorbate at 55 and 60°C improved the control of ecay compared to heated water alone, but differences after 3 and 7 days of incu-ıtion at 20°C were not significant. Treatments performed on inoculated fruit ored at 20°C with 90% RH were more effective compared to the ones performed ı fruit stored at 0°C indicating that also the temperature influences the efficacy the treatment, and it was suggested to be a host-resistance effect (Palou *et al.*,)10). This paper deals with the attempt to control postharvest decay during stor-ge and shelf-life of white and black prune *cvs* belonging to the Sardinian germo-asm by immerging the fruit in water for different times and temperatures with or ithout the addition of sodium bicarbonate (SBC).

ATERIALS AND METHODS

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hite prune fruit (*Prunus domestica*, L.) (*cvs* Core, Core Columbu, Fradis, Meloni) ɔm the Sardinian germoplasm and a black one (*cv* Sighera) were harvested when ature (at their optimal total soluble sold content). As a comparison, two interna-ɔnal varieties were used: 'Stanly' (black prune) and 'Shiro' (white plum; *Prunus licina*). All fruit was harvested in the experimental orchard in Oristano, Italy. ter harvest, fruit was selected in order to attain homogeneous replicates based ı size, maturity stage and without visible damage. Fruit was placed in one-layer ɔxes (40-60 fruit each) and conditioned for 24 h at 20°C and 90% RH before eatments.

eatment

eatments were performed by immersion of the fruit for 0 (control), 15, 30, 45 or) sec in sole water or in a 2% (W:V) sodium bicarbonate (SBC) solution at 20, 50, ; or 60°C. The immersion tank (50 L) was thermo-regulated by a heating-re-rculating device (DL30, Haake instruments, Inc., Paramus, N.J. USA,) and tem-

perature in the tank remained stable (±1°C) during the treatments. Following treatment fruit was left to dry in a ventilated room at 25°C and when dry all boxes were transferred to storage.

Storage

All fruit was stored in the same storage room for 4 weeks at 5°C and 90% relative humidity (RH) followed by a simulated shelf-life at 20°C and 80% (RH) for 6 days.

Decay monitoring

The amount of naturally infected fruit was accounted after the storage period and following the simulated shelf-life. Fruit was considered as infected when pathogenesis was evident, independently from the expansion area or sporulation degree. Un-immersed fruit was used as control.

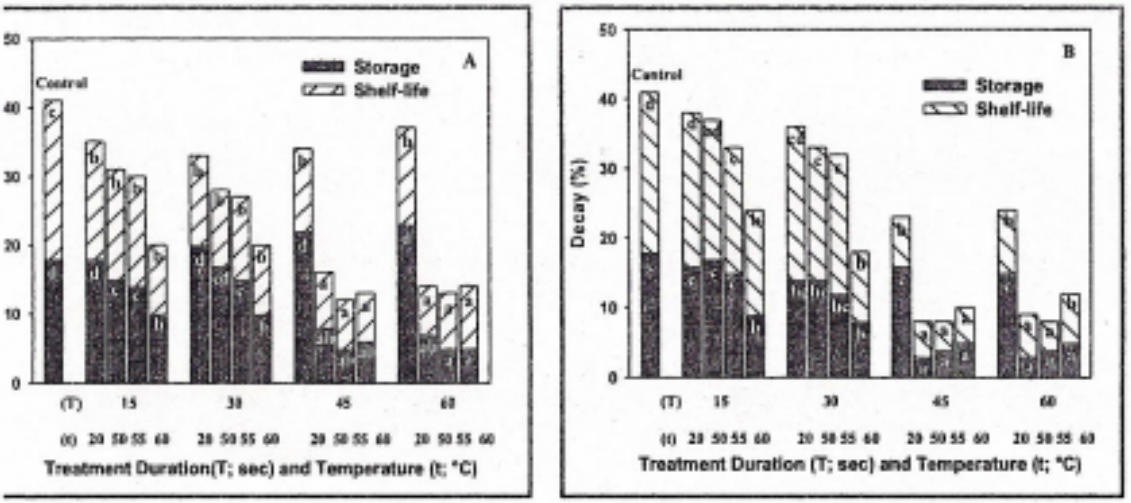
Statistics

All data were subjected to ANOVA using the OpenStat (2007) program, and where appropriate mean separation was performed according to the Newman-Keuls Test. Where needed, angular transformation was performed before ANOVA.

RESULTS AND DISCUSSION

Immersion in water or in a 2% SBC-solution at 20°C was not effective in protecting fruit from the natural occurrence of decay at any of the tested times. Decay was mainly caused by *M. fruticola*, *Botrytis cinerea* and *Rhizopus stolonifer*, and compared to the control (un-treated fruit), differences were negligible (Figure 1, 2, 3, 4). When the immersion was performed in water at 50, 55 or 60°C, a significant decrease of total decay occurred in all studied cultivars. The efficacy in controlling decay by 15 or 30 sec immersions was most marked during storage (especially at 60°C), while the inhibition effect was lost during the shelf-life and for most cultivars the percentage of decay was similar to that of the control. A similar trend was found for all studied cultivars with small differences between the percentages of decay monitored during storage and the simulated shelf-life period. This result may be related to specific differences in natural resistance among cultivars as observed by Corbin (1963). Since this effect was more marked in the white germplasm cultivars, it may be related to natural resistance factors as found by Lee and Bostock (2007). When the immersion was performed in the heated SBC-solution a small improvement was observed for all germplasm cultivars even though it was significant only for Sighera fruit immersed at 50, 55 or 60°C for 45 or 60 sec. In some cases (Figure 3, 4), the use of the heated SBC solution increased the percentage of rots during the simulated shelf-life period. In general, the results agree with those reported by Palou *et al.* (2009); this is different to the results found with *Citrus* fruit. Indeed, when heated SBC-solutions were applied to *Citrus* fruits, a significant reduction of decay occurred compared to water. These differences may be related to the differences of tissues involved in the two fruits (*Citrus* fruits are rich in pectins). By using the heated SBC-solution, the best result was obtained at 50 and 55°C. The lowest percentage of decay was attained when fruit was immersed at 60°C, but differences were not significant compared to the immersion in the SBC-solution at 55°C with SBC and some damage to the fruit rind was visible in some

ıltivars. The overall appearance score of 'Core', 'Core Columbu', 'Fradis' and hiro' decreased significantly after the shelf-life, especially when treated at 55 or)°C for 60 sec. Treatments at 60°C for 60 sec with SBC induced damage and as a ɔnsequence decay increased as clearly evidenced in Figure 1b, 2b, 3b and 4b. In eneral, local varieties were less affected by decay compared to the international ıes and they performed well during storage. Among the three main pathogens, ıts caused by *B. cinerea* were significantly reduced by using the heated SBC-ɔlution especially when treatments were performed for 45 or 60 sec at 50 and 5°C. Fruit shrivel was the main cause of the low rating. SBC did not affect shrivel-g incidence indicating that heat treatment may be the probable cause.



igure 1. Total decay (%) naturally occurred in white prune fruit *cv* Fradis during storage ( ) ır 4 weeks at 5°C and 90% RH and during 6 days of simulated shelf-life ( ) at 20°C and 80% H following immersion in water (A) or in a 2% (*w:v*) sodium bicarbonate solution (B) at dif-erent temperatures (T) and for different periods (t). Different letters within each staked bar dicates differences at $P \geq 0.05$ among treatment temperature and immersion duration during orage or shelf-life according to Newman-Keuls test; control fruit was not immersed in wa-r; N= 180 fruit.

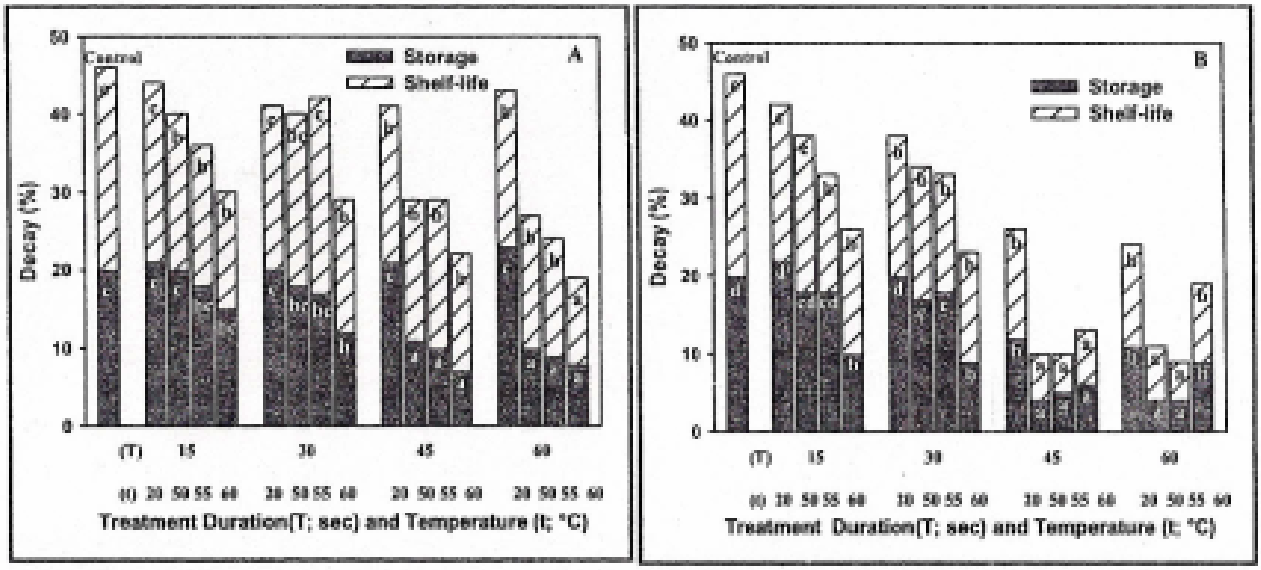


Figure 2. Total decay (%) naturally occurred in black prune fruit *cv* Sighera during storage (▩) for 4 weeks at 5°C and 90% RH and during 6 days of simulated shelf-life (▨) at 20°C and 80% RH following immersion in water (A) or in a 2% (w:v) sodium bicarbonate solution (B) at different temperatures (T) and for different periods (t). Different letters within each staked bar indicates differences at $P \geq 0.05$ among treatment temperature and immersion duration during storage or shelf-life according to Newman-Keuls test; control fruit was not immersed in water; N= 180 fruit.

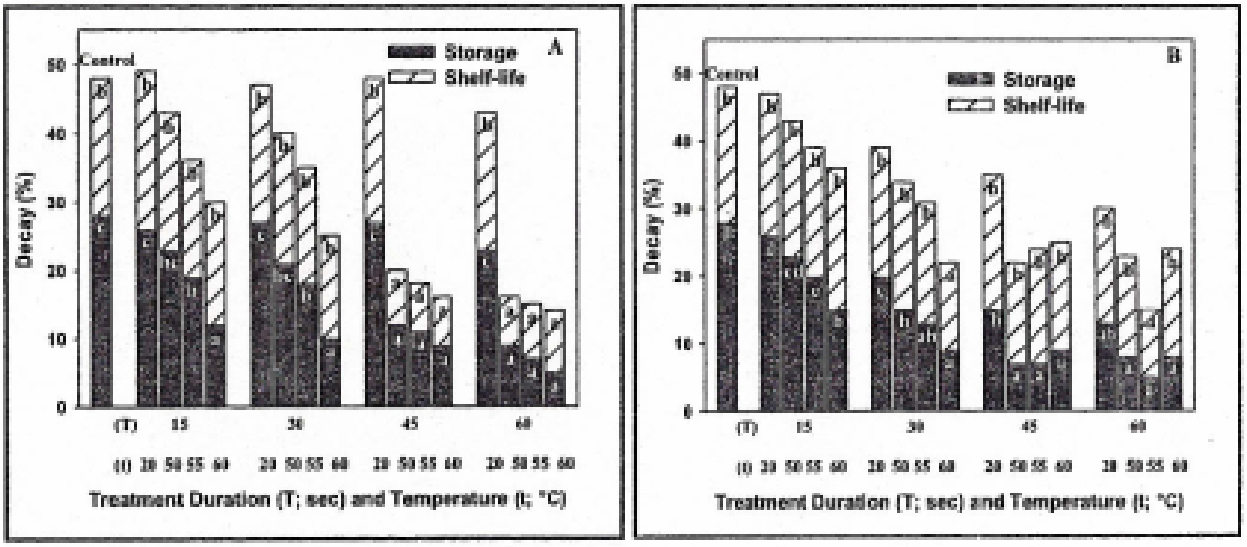
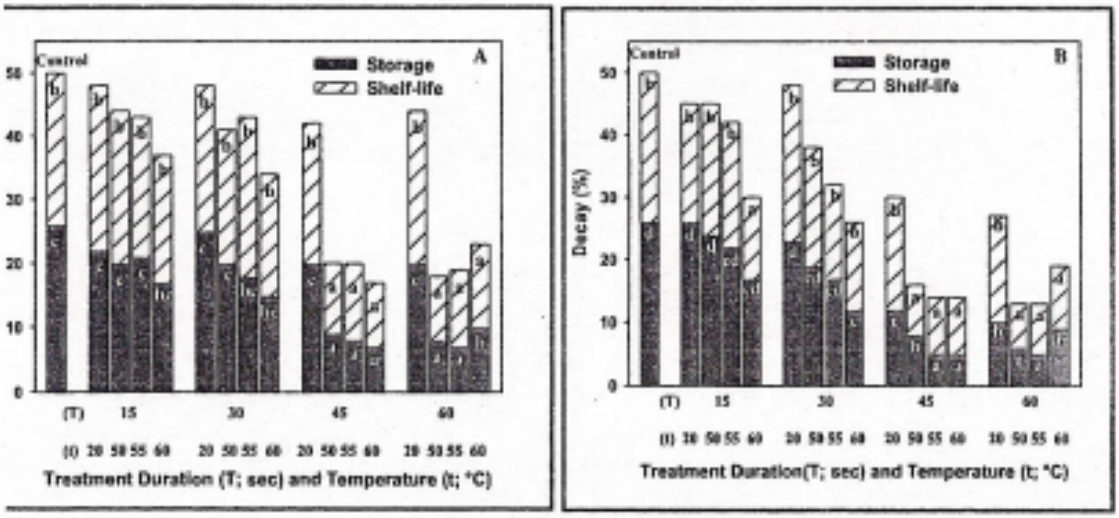


Figure 3. Total decay (%) naturally occurred in black prune fruit *cv* Stanly during storage (▩) for 4 weeks at 5°C and 90% RH and during 6 days of simulated shelf-life (▨) at 20°C and 80% RH following immersion in water (A) or in a 2% (w:v) sodium bicarbonate solution (B) at different temperatures (T) and for different periods (t). Different letters within each staked bar indicates differences at $P \geq 0.05$ among treatment temperature and immersion duration during storage or shelf-life according to Newman-Keuls test; control fruit was not immersed in water; N= 180 fruit.



gure 4. Total decay (%) naturally occurred in white plum fruit *cv* Shiro during storage (■) r 4 weeks at 5°C and 90% RH and during 6 days of simulated shelf-life (▨) at 20°C and 80% H following immersion in water (A) or in a 2% (w:v) sodium bicarbonate solution (B) at different temperatures (T) and for different periods (t). Different letters within each staked bar dicates differences at $P \geq 0.05$ among treatment temperature and immersion duration during orage or shelf-life according to Newman-Keuls test; control fruit was not immersed in water; N= 180 fruit.

ONCLUSION

onsidering that the overall appearance of the white prunes *cvs* 'Core', 'Core Combu', 'Fradis' and 'Shiro' decreased significantly after the shelf-life when fruit as treated at 55 or 60°C for 60 sec, the best compromise between decay control ficacy and keeping quality for the white cultivars should be the treatment with ated SBC-solution at 50 or 55°C for 45 sec.

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