ETHYLENE PRODUCTION AND STORAGE POTENTIAL IN 'CACANSKA NAJBOLJA' PLUMS

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A B S T R A C T

Our recent studies have shown that 'Cacanska Najbolja' plums have a very high storage potential. Fruit of this cultivar can be stored for up to eight weeks at -0.5°C with minimal internal breakdown and moderate loss of firmness. However, when 'Cacanska Najbolja' is stored at higher temperatures, at about 4°C for example, internal breakdown started during the fourth week of storage. The plums produced very little amount of ethylene, and were only slightly sensitive to externally applied ethylene while they were on the tree. The application of the ethylene inhibitor 1-methylcyclopropene (1-MCP) immediately after harvest did not increase their storage potential.

Key words: plum, *Prunus domestica* L., storage potential, internal breakdown, softening, 1-MCP

INTRODUCTION

Plums, especially European cultivars, can be stored for only a short time. They are highly susceptible to internal breakdown and softening, especially when stored at room temperature. The rate of softening can be largely reduced by controlling the storage temperature (Plich, 1998a). However, there is currently no way of delaying internal breakdown, the details of which are still poorly understood (Plich, 2000). Susceptibility to internal breakdown varies widely among plum cultivars (Plich, 1998b). Internal breakdown is affected by the level of ripeness at picking time and by the length of the storage period (Crisosto et al.,1995; Plich, 2000) In our ongoing studies, we have evaluated different plum varieties grown in Poland in terms of their storage potential

(Plich, 2004). ‘Cacanska Najbolja’ is a cross between ‘Wangenheim Prune’ and ‘Pożegacza Prune’ developed in the former Yugoslavia. It has been introduced into Polish orchards as an important commercial variety (Grzyb and Rozpara, 2000). In a six year study, ‘Cacanska Najbolja’ proved to be one of cultivars most tolerant to PPV infection grown in Europe (Zawadzka et al., 1998). There were very few symptoms of PPV infection on leaves and almost no symptoms on fruits of artificially infected trees. The aim of this study was to evaluate the storage potential of ‘Cacanska Najbolja’ in relation to ethylene production and sensitivity to externally applied ethylene.

MATERIAL AND METHODS

Two weeks before the expected picking time, some trees of ‘Cacanska Najbolja’ were sprayed with either 10 or 50 ppm of etephon. Fruit were picked twice, one week apart. Immediately after harvest, the plums treated with etephon and the untreated control plums were sealed in 20 litre aluminum tanks into which 1 ppm (v/v) 1-MCP (Ethylblock, Rohm and Haas, USA) was introduced. The fruit were kept for sixteen hours at room temperature (22-24°C). After being treated with 1-MCP, the plums were placed in plastic boxes (40 x 20 x 10 cm), each containing eighty plums. The boxes were placed in a cold room, where a temperature of -0.5°C was maintained during the whole storage period. Internal fruit quality indices (firmness, SSC and taste) were determined at harvest time and then every two weeks during storage, with three replicates of ten plums each for each treatment. The incidence of internal breakdown was evaluated at the same time with three replicates of fifty plums each throughout the entire eight week storage period. Fruit firmness was measured with an Instron Firmness Tester. SSC was measured with a hand-held refractometer. The rate of ethylene production was determined in tightly sealed, 3.75 litre glass jars after allowing the fruit to come to room temperature for ten hours. Samples were collected after ten hours of gas accumulation on the first, third and sometimes also the seventh day of ripening.

Data on fruit quality were statistically elaborated by analysis of variance and, where appropriate, means were separated by Fisher’s LSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Plum softening

The rate of plum softening while the plums were ripening on the tree is shown in Figure 1. The times at which etephon was applied and at which plums were picked are marked.

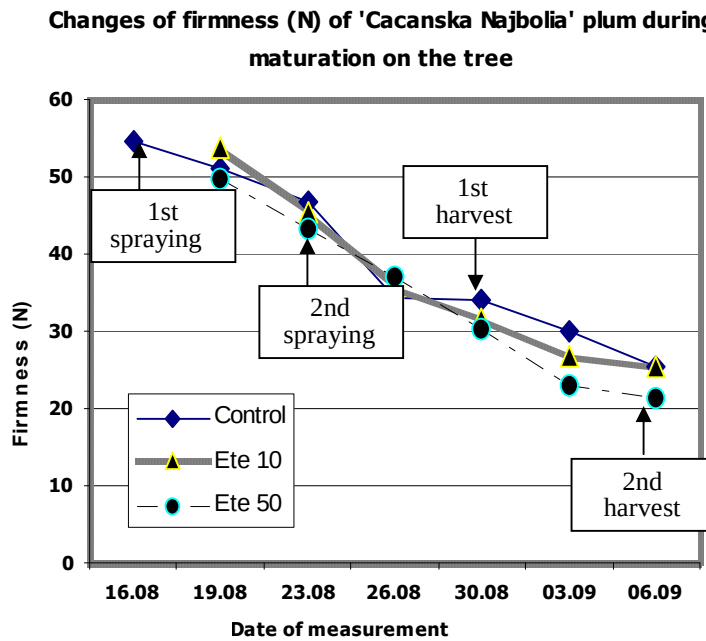

Figure 1. Changes of firmness [N] of ‘Cacanska Najbolja’ plum during ripening on the trees

T a b l e 1 . The effect of etephon and 1- MCP application on firmness [N] of plums ‘Cacańska Najbolja’ in relation to different time of treatment with etephon and period of postharvest storage

1A. After 2 weeks at –0.5°C plus one or three days at room temperature

Treatment	Sprayed on Aug.16, picked on Aug. 30		Sprayed on Aug. 23, Picked on Aug. 31	
	2 weeks at -0.5°C + 1 day at 22°C	2 weeks at -0.5°C + 3 days at 22°C	2 weeks at -0.5°C +1 day at 22°C	2 weeks at -0.5°C + 3 days at 22°C
Control	33.7	25.9	34.1	28.1
1- MCP 1	33.9	27.3	32.3	28.6
Etephon 10	31.4	25.9	28.1	20.4
Etephon 10+ 1-MCP	30.3	26.9	27.7	24.0
Etephon 50	30.8	24.8	25.8	21.0
Etephon 50+ 1-MCP	30.6	23.2	25.3	21.3
LSD at 0.05	3.1			

1B. After six weeks at –0.5°C plus one or three days at room temperature

Treatment	Sprayed on Aug. 16 picked on Aug 30		Sprayed on Aug.23 picked on Aug. 31	
	6 weeks at -0.5°C + 1 day at 22°C	6 weeks at -0.5°C + 3 days at 22°C	6 weeks at -0.5°C + 1 day at 22°C	6 weeks at -0.5°C + 3 days at 22°C
Control	30.9	27.8	31.7	28.0
1- MCP	32.0	29.4	32.6	29.0
Etephon 10	31.6	27.5	27.4	20.5
Etephon 10+ 1-MCP	32.4	28.5	28.1	19.7
Etephon 50	28.9	25.0	23.4	17.3
Etephon 50+ 1-MCP	30.1	26.6	25.0	22.0
LSD at 0.05	3.0			

During the last three weeks of ripening on the tree, plum softening progressed very slowly at a rate of about 1.4-1.5 N per day. Spraying trees with 50 ppm of etephon had only a slight effect on softening in plums when the plums were on the tree, but it had a marked effect when the plums were in storage (Tab.1). Etephon treatment on August 23, the second date of spraying, had a larger effect than treatment on August 16. Softening in plums treated with etephon was considerably greater when the plums were kept for a longer time at room temperature. In plums not treated with etephon, firmness remained almost unchanged throughout the whole cold storage period (compare Table 1A and 1B).

Ethylene production

At harvest time and on the day the plums were transferred to room temperature after two weeks of cold storage, they produced only negligible amounts of ethylene (Fig. 2). Ethylene production did not increase much during the seven day shelf life at room temperature. Ethylene production capacity increased with the length of cold storage, was higher after four weeks of cold storage, and reached a maximum after six weeks (Fig. 3). On the day the plums were transferred to room temperature, the rates of ethylene production after two, four and six weeks of cold storage were comparable (Fig. 3). However, there were marked differences during the shelf life period (Fig. 4).

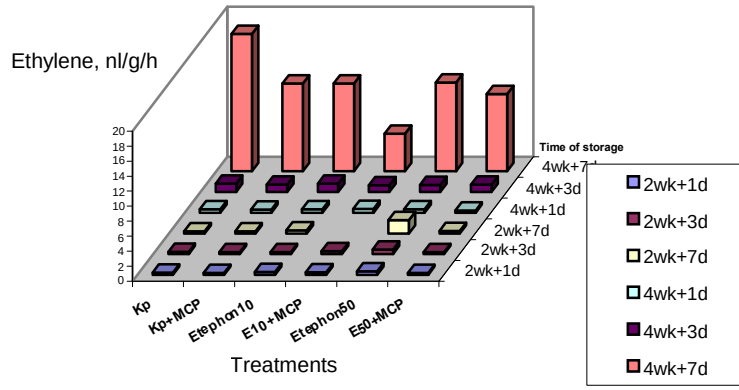

Figure 2. Ethylene production in ‘Cacanska Najbolja’ plums treated on the tree with etephon after two or four weeks of storage at -0.5°C followed by one, three or seven days at room temperature
(Spraying with etephon on Aug. 16; first picking Aug. 30)

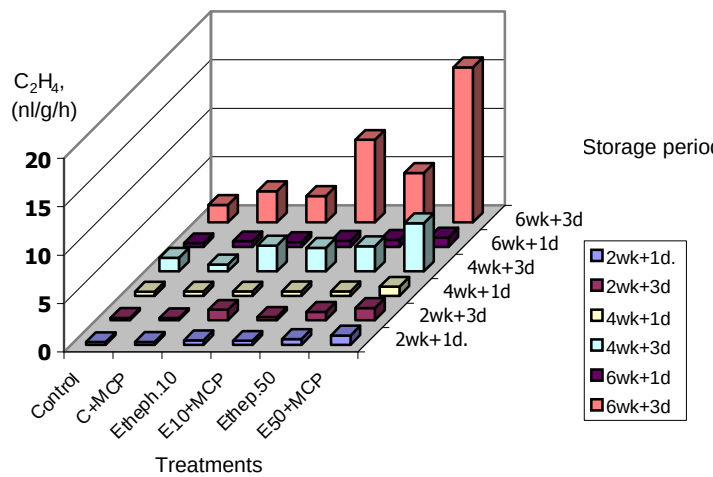

Figure 3. Ethylene production in plums treated on the tree with etephon (E) and just after harvest with 1-MCP after two or four weeks of storage at -0.5°C followed by one or three days at room temperature
(Spraying with etephon on Aug. 23; first picking Aug. 31)

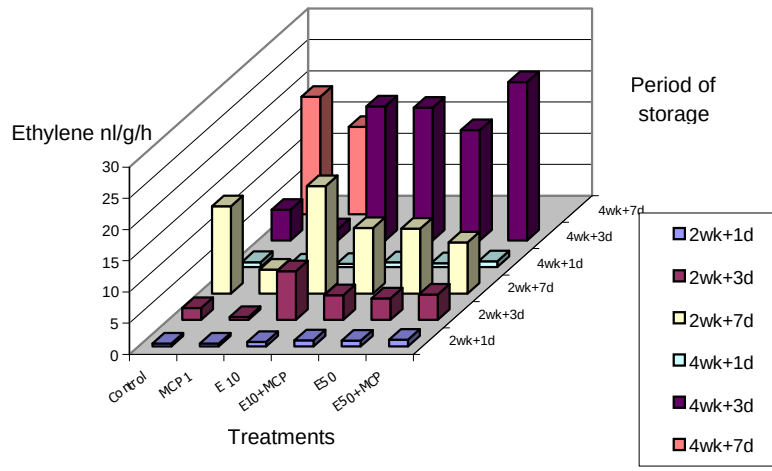

Figure 4. Ethylene production by plums treated with ethephon on the tree and just after harvest with 1-MCP after 2 and 4 weeks storage at -0.5°C followed by one, three or seven days at room temperature
(Spraying with etephon on Aug. 23; second picking Sept. 6)

Internal breakdown

Table 2. Occurrence of internal breakdown [%] in 'Cacanska Najbolja' plums treated on the tree with etephon [in µl/L] and 1-MCP [in nl/L] just after harvest during long-term cold storage

Treatment	Storage period at –0.5°C (weeks)			
	2	4	6	8
Control	0	1	0	6
1-MCP	0	0	0	2
Etephon 10	0	1	0	3
Etephon 10 +1-MCP	0	0	0	3
Etephon 50	0	0	0	4
Etephon 50 +1-MCP	0	0	0	3

'Cacanska Najbolja' is less susceptible to internal breakdown than the cultivars which had been previously evaluated (Plich, 2004). When stored at -0.5^0C, internal breakdown did not develop until the eighth week (Tab. 2). Even the plums treated with etephon were comparatively resistant to internal

breakdown. However, when the plums were stored at +4°C, internal breakdown started to develop in the fourth week (Fig. 5). 1-MCP did not have any effect on the development of internal breakdown and its effect on both ethylene production capacity and softening was inconsistent.

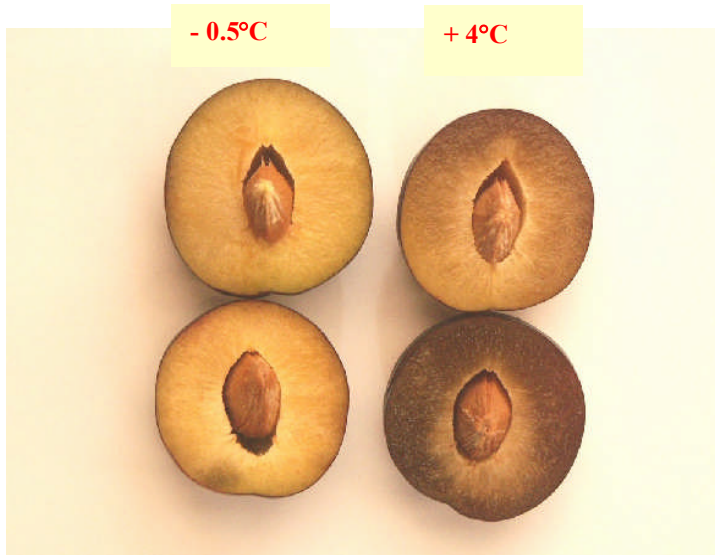

Figure 5. Internal breakdown development in ‘Cacanska Najbolja‘ plums after four weeks of storage at two temperatures

CONCLUSIONS

1. Storage potential of ‘Cacanska Najbolja’ plums is high. At temperature –0.5°C they can be stored for up to eight weeks with minimal internal breakdown and moderate loss of firmness.
2. Fruit of this plum cultivar produced little ethylene at harvest time and the ethylene production capability was gradually increasing during long term cold storage but it was a very slow process. Application of etephon, a source of exogenous ethylene, at 50 ppm only slightly accelerated plum softening on the tree and caused a little faster softening of them during long term cold storage.
3. The effects of 1-MCP applied at 1 ppm immediately after harvest on ethylene production and plum fruit quality were very inconsistent. It seems to us that 1-MCP rather do not influence on storage potential of plum.

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ZDOLNOŚĆ PRZECHOWALNICZA ŚLIWEK ODMIANY ‘CACANSKA NAJBOLJA’ I JEJ ZWIĄZEK Z PRODUKCJĄ ETYLENU

Henryk Plich

S T R E S Z C Z E N I E

Œliwki ’Cacanska Najbolja’ charakteryzuj¹ siê relatywnie du¿¹ trwa³oœci¹ po zbiorze. W temperaturze -0.5°C mog¹ byæ przechowywane przez 8 tygodni zachowuj¹c wysok¹ jakoœæ. W tym czasie zachodzi niewielki rozpad wewnêtrzny mi¹¿szu i spadek jêdrnoœci jest umiarkowany. Jednak w temperaturze wy¿szej (3-4°C) wyst¹pi³y wyraŸne symptomy rozpadu wewnêtrznego mi¹¿szu ju¿ w czwartym tygodniu przechowywania. W okresie ostatnich 3 tygodni dojrzewania na drzewie owoce tej odmiany wytwarza³y niewielkie iloœci etylenu i by³y ma³o wra¿liwe na dzia³anie etefonu (Ÿród³o egzogennego etylenu). Aplikacja bezpoœrednio po zbiorze inhibitora dzia³ania etylenu (1-MCP) nie mia³a wp³ywu na trwa³oœæ owoców tej odmiany w czasie przechowywania w –0.5°C.

Słowa kluczowe: śliwki, *Prunus domestica* L., potencjał przechowalniczy, rozpad wewnętrzny, jędrność, 1-MCP