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The influence of ethephon applied before harvesting on vitamin C, reducing sugars, protein total, and carotenoids content in the fruits of sweet pepper PCR (*Capsicum annuum* L.)

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Abstract

Changes were examined in vitamin C, protein total, reducing sugars, and carotenoids content in fruits of sweet pepper treated with ethephon (2-chloroethylphosphonic acid) before harvesting the fruits. The obtained results show that epplying ethephon caused an increase in vitamin C and carotenoids total content in fruits of pepper harvested 35 days after spraying. With an increase of xantophyll concentration (capsanthin + capsorubin) effected by ethephon, a decrease in β-carotene occurred, and with an increase in the amount of β-carotene a decrease in the amount of red carotenoids in pepper fruits was found.

INTRODUCTION

For several years the influence of applying ethephon before harvesting the fruits on the ripening of sweet pepper both in greenhouse and in field experiments has been examined (Batal and Granberry, 1982; Conrad and Sundstrom, 1987; Knavel and Kemp, 1973; Osterli et al., 1975; Perucka and Bubicz in press; Sims et al., 1974). Earlier research has shown that ethephon increases fruit ripening depending on the concentration of the preparation applied (Batal and Granberry, 1982; Conrad and Sundstrom, 1987; Knavel and Kemp, 1973) and on the weather conditions (Sims at al., 1974). The present experiment was expected to supply information about the way in which applying ethephon influences the content of the substances which determine the nourishing values of sweet pepper, i.e. of reducing sugars, protein total, vitamin C and carotenoids. Carotenoids contained in sweet pepper are not only the source of provitamin A (β-carotene), but also of

natural pigments used in food industry (F i s c h e r and K o c i s, 1987). The aim of the experiment was to define the influence of applying athephon before harvesting the fruits on induction of yellow carotenoid pigments: β-carotene, zeaxanthin, antheraxanthin, violaxanthin, cryptoxanthin, and red ones-capsanthin and capsorubin, in the fruits of sweet pepper.

MATERIALS AND METHODS

Fruits of seet pepper *Capsicum annuum* var. PCR were used for the investigation. They came from the experiment conducted in the field of Institute of Horticultural Production of the Agricultural University in Lublin. The preparation (Flordimex TH – produced in GDR) was applied by spraying the plants in two concentrations: 1-0,05 %, and 2-0,2 %. The concentrations were chosen as the most favourable in the greenhouse (P e r u c k a and B u b i c z, in press). The plants were sprayed in the initial stage of fruit ripening (30 % of the fruits were dyed). The experiment was arranged in a randomized complete block design with 4 replications per treatment. Each replication consisted of 20 plants. For analysis fruits fully ripened were taken at three times: I – 5; II – 15; and III – 35 days after spraying the plants with ethephon. In the fruits changes of vitamin C, reducing sugars, protein total, and carotenoids concentration were examined. Vitamin C concentration was determined by the modified Tilmans method (Ro e, 1967), reducing sugars – by the Hagendorf-Jansen method in Fujite and Iwateke modification (K a c z k o w s k i and T o c z k o, 1969). Protein total concentration was determind by the Kjeldahl method on Kjel-Foss Denmark. Carotenoids were separated on a chromatographic column filled with calcium hydroxide, and then their concentration was determined spectrophotometrically (B o t h, 1957). β-carotene and other carotenoids were identified by thin-layer chromatography method (D a v i e s et al., 1970). The data were analysed statistically using the doubly cross classification system and Tuke's range of confidence at the level L = 0,05.

RESULTS

The changes in dry matter, vitamin C, protein total, and reducing sugars content in the fruits of sweet pepper treated with ethephon are presented in Table 1. Fruits harvested 35 days after spraying had a maximum dry matter

content. The application of the preparation caused a decrease in dry matter content by about 10 % with concentration of 0,2 %.

Greater changes were observed in the case of vitamin C. Its content was highest in fruits harvested 35 days after spraying. The concentration of this vitamin was increased by applying ethephon, and reached its maximum with the concentration of 0,2 %.

The concentration of protein and reducing sugars did not undergo distinct changes. Only a slight decrease in protein total content was observed under the influence of the applied preparation, as well as a slight increase in sugars content. The changes in carotenoids concentration are presented in Table 2. The obtained results point to the fact that applying ethephon mainly influenced β-carotene and red carotenoid pigments, capsanthin and capsarubin, content. It was found that applying ethephon in all concentrations caused an increase in the percentage of β-carotene content as compared to all pigments and at the same time a decrease in the amount of red pigments in fruits harvested 5 days after spraying as compared to the control. In fruits harvested 30 days later a lower β-carotene content and an increased red pigments content under the influence of the applied preparation was found. No effect of ethephon on the content of the other yellow carotenoid pigments was found.

Table 1

Dry matter, protein total, reducing sugars, vitamin C content in fruits of sweet pepper treated with ethephon (% of fresh matter)

Days after treatment	Ethephon	Dry matter	Protein total	Reducing sugars	Vitamin C (mg x kg $^{-1}$)
5	0	8,53	1,28	2,67	1180,0
	1	9,36	1,32	3,11	1232,8
	2	8,14	1,20	2,61	1106,6
15	0	9,02	1,46	2,99	1217,9
	1	8,76	1,33	2,82	1371,2
	2	8,18	1.30	2,51	1106,6
35	0	10,18	1,77	2,77	1384,0
	1	10,46	1,73	3,02	1639,2
	2	9,01	1,49	2,59	1735,5
LSD		0,45		0,06	5,08

Table 2

Effect of applying ethephton before harvesting on carotenoid content in fruit of sweet pepper

Days after treatment	Ethephon	Carotenoid total (mg x kg^{-1} of fresh matter)	β–carotene*	Yellow carotenoides*	Red carotenoides*
5	0	74,77	4,10	37,74	58,16
	1	84,83	5,40	37,26	57,34
	2	75,04	6,60	38,60	54,80
35	0	138,00	11,13	24,76	64,11
	1	146,44	11,20	24,97	63,81
	2	144,59	9,89	23,66	66,45
LSD		5,96	0,47		

Note: * – percent in carotenoid total

DISCUSSION

The results obtained in the present research show that applying ethephon before harvesting does not lower the quality of sweet pepper fruits, on the contrary, it increases vitamin C concentration.

The present research confirms the earlier ones (B a t a l and G r a n b e r r y, 1982; B u e s c h e r and H e n d e r s o n, 1978; K n a v e l and K e m p, 1973; P e r u c k a and B u b i c z, in press), showing that ethephon effects an increase in carotenoid concentration. An analysis of the percentage of β-carotene, the other yellow and red carotenoid pigments showed that ethephon mainly influenced β-carotene and red pigments content. The effect of this preparation depended on the time elapsing from spraying to examination (C o n r a d and S u n d s t r o m, 1987). It was found that along with an increase in β-carotene concentration, red pigments concentration decreased (5 days after spraying) and conversely, along with an increase in red xanthophylls concentration, the concentration of β-carotene decreased (35 days after spraying). It should be assumed that ethephon may play the role of inhibitor in the process of xanthophylls reduction, depending on the time of its action, which causes their accumulation, with the result being most conspicuous when the concentration applied is 0,2 %.

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Wpływ etefonu stosowanego przed zbiorem na zawartość witaminy C, cukrów redukujących, białka ogólnego i karotenoidów w owocach papryki słodkiej PCR *Capsicum annuum* L.

Streszczenie

W pracy przedstawiono wyniki badań wpływu kwasu 2-chloroetylofosfonowego stosowanego przed zbiorem owoców na zawartość witaminy C, cukrów redukujących, białka i karotenoidów w owocach papryki słodkiej PCR. Etefon zastosowano w stężeniu 0; 0,05 i 0,2 % w formie oprysku na rośliny w początkowej fazie dojrzewania owoców. Do analiz zbierano owoce w trzech terminach w miarę ich dojrzewania. W wyniku przeprowadzonych badań stwierdzono, że owoce zbierane w późniejszym terminie posiadały wyższą zawartość witaminy C, β-karotenu i czerwonych barwników karotenoidowych. Zawartość żółtych barwników uległa zmniejszeniu. Przedźniwne stosowanie etefonu nie obniżyło jakości owoców. Otrzymane wyniki badań wykazały, że zastosowanie etefonu spowodowało wzrost zawartości witaminy C i sumy karotenoidów w owocach papryki. Przy wzroście stężenia β-karotenu w owocach traktowanych etefonem, występowało obniżenie zawartości czerwonych barwników, a przy wzroście ilości czerwonych karotenoidow – obniżenie zawartości β-karotenu. Nie stwierdzono natomiast wpływu etefonu na zawartość żółtych barwników karotenoidowych.