Dissipation of pesticides from glass-cultured tomato and their presence in the dried tomato product

Katalin Lányi*, Lívia Darnay, Eszter Balogh, Cecilie M. Andvord and József Lehel

University of Veterinary Medicine Department of Food Hygiene,

István u. 2. H-1078 Budapest, Hungary

**e-mail: lanyi.katalin@univet.hu*

Abstract

Behaviour of pesticides during plant cultivation and food processing is an issue of high importance from human health and environmental safety points of view. In our research we studied the fate of two pesticide active ingredients, spirotetramat and metalaxyl-M (of Movento and Ridomil products, respectively) whether these influence each other's dissipation from the plant after treatment, and how these are appearing on the dried tomato, as a processed product. The results show that the two compounds indeed influence the other's dissipation process, however, the details of this influence are not clear yet.

Keywords: pesticides, food processing, cross-effects

Összefoglaló

A peszticidek növénytermesztés és élelmiszer-feldolgozás során mutatott viselkedése nagyon fontos a human egészség és a környezetvédelem szempontjából. Kutatásunk során két növényvédőszer hatóanyag, a spirotetramat és a metalaxil-M (a Movento, illetve a Ridomil hatóanyagai) esetében vizsgáltuk, hogy együttes jelenlétük befolyásolja-e a kiürülési folyamatot, illetve, hogy milyen módon jelennek meg a termékként előállított szárított paradicsomon. Az eredményeink azt mutatták, hogy a két vegyület nyilvánvalóan befolyásolja a másik kiürülését, bár ezen befolyás mikéntjei még nem teljesen tisztázottak.

Kulcsszavak: peszticidek, élelmiszer-feldolgozás, kereszt-hatások

Introduction

Knowledge of the fate of pesticides used in agricultural practice is very important to properly assess human exposure and the environmental impact of these xenobiotics. Vegetables are an important component of human diet due to being a good source of vitamins that are essential for human health. The scientific and professional community have long been interested in the effect of processing technologies on the presence and level pesticide residues in food. The extent to which pesticide residues are removed by food processing technologies may depend on a variety of factors, such as the chemical properties of the pesticide, the nature of the food itself, or the length of time the compound has been in contact with the food (Samriti & Kumari (2011); Chavarri et al. (2005); Farris et al. (1992); Holland et al. (1994); Zhang et al. (2015); Wang et al. (2014); Malhat (2017)).

The aim of our research was to determine the levels of various pesticides on the tomato and the dried tomatoes prepared from it. Insecticide and fungicide were applied separately and in combination, in order to allow for observe the possible effects these chemicals may have on each other's behaviour on the vegetable.

Material and method

Tomato growing

The tomato plants used in our study were grown in the experiment cabins inside the green house of John von Neumann University Faculty of Horticulture and Rural Development in Kecskemét, where hydroculture cultivation can be carried out in feeding channels. The tomato seedlings were planted into Grodan Delta rock wool cubes and placed on rock wool quilt that was the growing medium. The seedlings (in all 72 pieces) were placed into a two times three-row (12 seedlings per row), separable, detachable box. The planted tomatoes belonged to the Soliance F1 indeterminate tomato variety. Its fruits are 120-140 gram in weight, slightly flattened and rounded with bright deep red colour. Due to its short joint it is recommended also in houses with lower wire height. It sets well also at higher temperature values.

Treatments

The insecticide and fungicide products used separately and in combination can be seen in the table 1.

1. Table. The insecticide and fungicide used in the trials

	Insecticide	**Fungicide**
Product's name	Movento	Ridomil Gold MZ 68 WG
Active ingredient	spirotetramat, 100 g/L (CAS No. 203313-25-1)	mancozeb, 640 g/kg (CAS No. 8018-01-7) metalaxyl-M, 38.8 g/kg (CAS No. 70630-17-0)
MRL for tomato:	2 mg/kg	metalaxyl-M 0.2 mg/kg mancozeb 3 mg/kg
Withdrawal period for tomato	3 days	7 days
Manufacturer	Bayer CropScience S.A.S.	Syngenta AG
Application in tomato	for the control of aphids, glasshouse whiteflies, thrips and spider mites	for the control of tomato late blight (Phytophthora infestans), alternaria and septoria diseases
Maximum number of treatments	2	3
Minimum duration between two treatments	7 days	7 to 12 days
Recommended dose	0.75 L/ha	maximum 2.5 kg/ha
Spray amount	800 to 1500 L/ha	400 to 800 L/ha

The plants of group I were treated with Movento insecticide (spirotetramat) in truss zone 1. The preparation was applied in a concentration of 0.9 ml/L with totally 4 litres of spray by row. To the plants in group II Ridomil Gold MZ 68 WG fungicide (metalaxyl-M and mancozeb) was applied in a dose of 3 g/L also in truss zone 1. From the preparation also 4 litres of spray was used by row. For an interaction study the combination of these two pesticides were used in the same dose and quantity. No separate group was set, as owing to the variety of the tomato truss zone 2 of group I was treated after the statutory withdrawal period, i.e., 7 days had expired. The plants were sprayed in each case in the morning on the day of treatment. The experimental setting is shown in table 2, the schedule of sampling in the table 3. The sampled quantity was 500 g each time, taken from several points of the plants.

2. Table. Experimental setting

Pesticide	Dose	Concentration	Group			
			I		II	
			Truss zone 1	Truss zone 2	Truss zone 1	Truss zone 2
Movento	0.75 (L/ha)	0.9 (ml/L)	+	+	-	-
Ridomil Gold MZ 68 WG	2.5 (kg/ha)	3 (g/L)	-	+	+	-

3. Table. Schedule of sampling

TREATMENT			SAMPLING				
Truss zone	Insecticide	Fungicide	Before treatment	Treatment day*	After treatment		
					Day 2	Day 4	Day 8
1	Movento	-	x	x	x	x	
	-	Ridomil	x	x	x	x	x
2	Movento	Ridomil	x	x	x	x	x

** after drying up*

Preparation of dried tomatoes

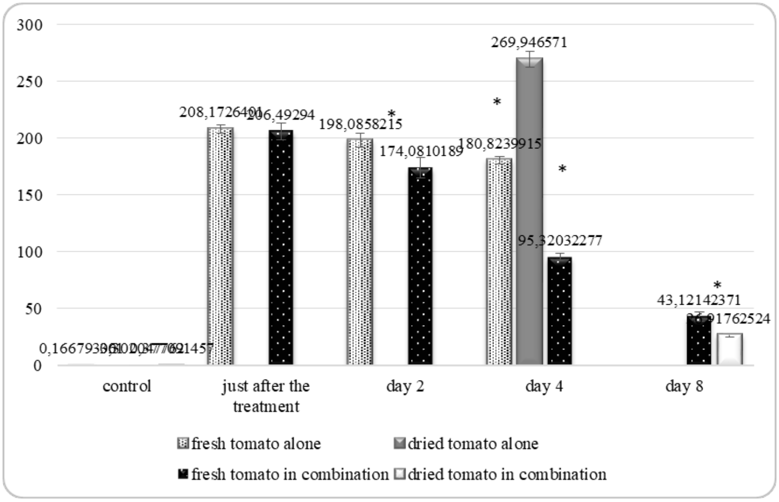
Dried tomatoes were prepared from the samplings before treatment and the last day of experiment (4th and 8th day for Movento and Ridomil & combination treatment, respectively). Drying was carried out in a household vegetable drier at 65 ºC for 6 hours.

Laboratory analysis

Following a QuEChERS sample extraction method, the pesticide concentrations were measured on a Shimadzu LCMS-8030Plus system and a Phenomenex Kinetex C18, 100 x 4,6 mm ID (2,6 µm particle size) LC column. Gradient elution was used by gradually changing the ratio of eluent ‘A’(50 mM ammonium-acetate in water, pH set to 5,0 with acetic acid) and eluent ‘B’ (0.1 v/v% formic acid in acetonitrile). Flow rate was set to 0,3 mL/min; one chromatographic run lasted for 8 minutes. Column oven was set to 30 °C, the samples were kept at 5 °C in the autoinjector. The injected volume was 10 µL. The mass spectrometer was operated with the electrospray (ESI) ion source in positive multiple reaction monitoring (MRM) mode. Since the mancozeb was not soluble in polar solvents suitable for reversed-phase liquid chromatography, this compound was not measured.

Results and discussion

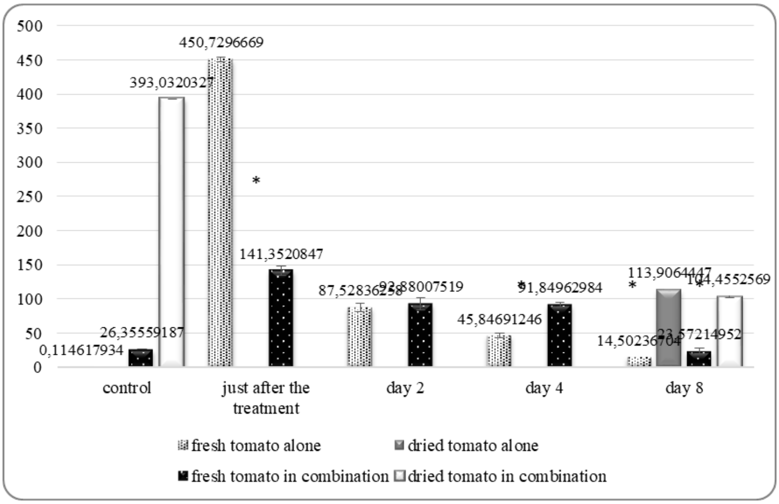
Spirotetramat, Movento's active ingredient did not reach the MRL concentration (2 mg/kg) even just after the drying of the spray on the plants. This result could be expected from the applied dose of this pesticide. The dissipation of spirotetramat when applied separately, or in combination the Ridomil showed similar patterns (Figure 1.). However, the concentration of spirotetramat decreased quicker when applied in combination. From the day 2, the difference between the concentrations of the separate and combined trials differed significantly ($p<0.05$). On the 4th day, the concentration measured for the combined trial was only about the half of those of separate trial. This suggests that the dissipation of this compound is rather strongly influenced by the presence of an other xenobiotic molecule.



*significant difference ($p<0.05$)

1. Figure. Measured concentrations of spirotetramat at the various sampling times

The pattern was far less clear in the case of metalaxyl-M, one of the Ridomil's active ingredients. Although the effect of an other pesticide was well visible also in this case, the results were less consistent. Considerable amount of the compound was measurable even on the control tomatoes. This could be possibly caused by the experimental arrangement. Significantly less metalaxyl-M was measured on the tomatoes just after the treatment in the case of combined trial. Only one-third of the levels measured when applied Ridomil alone was measurable. On the second day, there was no significant difference between the two trials' results, while on the days 4 and 8, there was significantly more metalaxyl-M in the combined treatment remaining on the tomatoes. The concentration value measured in the separate trial just after the treatment was higher than the MRL (0.2 mg/kg), however, vegetables from times so close to the pesticide treatment shall no reach the food chain anyway.



*significant difference (p<0.05)

2. Figure. Measured concentrations of metalaxyl-M at the various sampling times

The pesticide concentrations in the dried tomatoes was generally higher than those in the fresh ones. This is an expected result, due to the concentration increase originating from the water loss during the drying. On the other hand, this also highlights that no considerable heat degradation occurred to the examined pesticides at the circumstances of drying.

Our results outline some important features in the behaviour of some pesticides during plant growing and food processing. More detailed research is needed to deeper understand this issue.

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References

Samriti R. Ch. and Kumari B. 2011. Bull Environ Contam. Toxicol. 87. 198-201.
Chavarri M.J., Herrera A. and Ariño A. 2005. Int. J. Food Sci. and Techn. 40. 205-211.
Farris G.A., Cabras P. and Spanedda L. 1992. Ital. J. Food Sci. 3. 149-169.
Holland P.T., Hamilton D., Ohlin B. and Skidmore M.W. 1994. Pure and Applied Chemistry 66. 335-356.
Zhang Q., Zhang, G., Yin P., Lv Ph., Yuan S., Chen J., Wei B. and Wang C. 2015. Chemosphere 139. 138-145.
Wang M., Zhang Q., Cong L., Yin W. and Wang M. 2014. Chemosphere, 95. 241-246.
Malhat F.M. 2017. Arab. J. Chem, 10. 1. 765-768.