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ScienceDirect

Food Control 20 (2009) 11–16

FOOD CONTROL

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Residue content of oxytetracycline applied on tomatoes grown in open field and greenhouse

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Received 10 May 2007; received in revised form 15 January 2008; accepted 23 January 2008

Abstract

A study was undertaken to evaluate the decline of the residues of oxytetracycline (OTC) in tomatoes grown in two different cultivation systems: open field (conventional cultivation) and greenhouse (protected cultivation). Tomato plants were subjected to a single chemical treatment, when fruits were at the breaker stage of maturation, by applying a commercial formulation at the doses recommended by the manufacturer. Fruit samples provided from open field and greenhouse were simultaneously and periodically taken until the end of the pre-harvest interval and submitted to analysis. A liquid–liquid extraction (LLE) and a silica-based C_{18} (octadecyl) solid-phase extraction (SPE) were used for sample preparation. High performance liquid chromatography (HPLC) with fluorescence detection was used to determine the OTC residues. Results showed that the recommended pre-harvest interval, indicated on the prospectuses of manufacturer, lowered the residue levels to acceptable legal limits and no statistical differences were observed between the cultivation systems in relation to the residue levels of OTC.

Keywords: Tomatoes; Antibiotic residue; Oxytetracycline; Greenhouse; Open field

1. Introduction

The tomato (*Lycopersicon esculentum* Mill.) belongs to the *Solanaceae* family and is an important vegetable crop worldwide. In Brazil, during 2005, it was harvested on 58,385 ha and the production was 3.3 million tonnes, with a productivity of 5658 tonnes ha^{-1} (FAO, 2005). Tomatoes, aside from being tasty are nutritious as they are, among other nutrients, a good source of vitamins A and C. Cooked tomatoes and tomatoes products are the best source of lycopene, which is a very powerful antioxidant and is helpful in preventing the development of many forms of cancer. Hence, this crop is gaining importance both in developing and developed countries and efforts are being made for the quality and quantity production of this commodity (Mahajan & Singh, 2006).

Tomato is a rapidly growing crop with a growing period of 90–150 days. It is a daylength neutral plant. Optimum mean daily temperature for growth is 18–25 °C with night temperatures between 10 and 20 °C. Larger differences between day and night temperatures, however, adversely affect yield. The crop is very sensitive to frost. Temperatures above 25 °C, when accompanied by high humidity and strong wind, result in reduced yield. Night temperatures above 20 °C accompanied by high humidity and low sunshine lead to excessive vegetative growth and poor fruit production. High humidity leads to a greater incidence of pests and diseases and fruit rotting. Dry climates, are therefore, preferred for tomato production and the plant can be grown on a wide range of soils but a well-drained, light loam soil with pH of 5–7 is preferred.

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doi:10.1016/j.foodcont.2008.01.007

Waterlogging increases the incidence of diseases such as bacterial wilt (FAO, 2007).

Plant diseases caused by bacteria are factors that affect tomato production throughout the world. Tomato is prone to a number of bacterial diseases, among which bacterial canker disease caused by *Clavibacter michiganensis* ssp. *michiganensis* is one of the most important. Bacterial canker symptoms include vascular wilt, leaf spots and fruit spots. Bacterial spot, *Xantomonas campestris* pv. *vesicatoria* and bacterial speck, *Pseudomonas syringae* pv. *tomato* cause similar foliar symptoms. Nearly 100% crop loss can occur (Pernezny, Kůdela, Kokošková, & Hládká, 1995; Umesha, 2006).

Bacterial diseases are difficult to control and may be introduced with transplants and, occasionally, have been associated with seed. Various measures have been suggested to manage them and include the use of certified disease-free seeds, resistant cultivars healthy transplants, disinfection and management of infectious disease agents and the use of biocontrol agents. The chemical protection of tomatoes is commonly carried out by schedule treatments, using applications of copper or agricultural antimicrobials (Lopes & Quezado, 1997; Umesha, 2006).

Oxytetracycline (OTC) is a member of the family of the tetracyclines and is used to control microbial infections in humans and animals and have also found applications in preserving harvest fruits and vegetables (Hernández, Borrul, & Callul, 2003).

Even when applied legally, many antimicrobials may leave residues in or on treated food such as fruits, vegetables, grains and other commodities. These residues may remain in both fresh produce (like apples or tomatoes) and processed foods (like applesauce or tomato ketchup). In an attempt to address the health issues associated with the consumption of these residues, the regulatory agencies set tolerance, or maximum residue limits (MRLs), on the amount of the antimicrobial residue that can lawfully remain in or on each treated food commodity. When these compounds are applied according to good agricultural practices, MRL are not exceeded, but their incorrect applications may leave harmful residues, which involve possible health risk and environmental pollution. Widespread antibiotic use for the treatment of agricultural infections can result in contamination in various environments including grounds and water (Cengiz, Certel, Karakaş, & Göçmen, 2007).

The Joint FAO/WHO Expert Committee of Food Additives and Contaminants (JECFA), at its 50th Meeting (1998), established a group acceptable daily intake (ADI) of 0–0.03 mg kg^{-1} body weight for oxytetracycline, tetracycline and chlortetracycline. No MRLs were recommended for foods of vegetable origin (WHO, 1998). Tolerances were established in the USA by the Environmental Protection Agency (EPA) for residues of oxytetracycline in or on peach and pear (MRL 0.35 mg kg^{-1}) (EPA, 2005).

In Brazil, the Ministry of Agriculture has established the use of OTC for cultivation of some food commodities: tomato, potato, beans, cucumber, coffee, peach, plum, passion fruit and pepper. The maximum residue limit (MRL) permitted is 0.25 mg kg^{-1} for all commodities, except for plum (MRL 0.7 mg kg^{-1}) (Brasil, 1985).

The widespread utilization of tetracyclines leads to an increasing resistance factor, so accurate monitoring by public health agencies is required. OTC can be successfully determined in various biological matrices and several reports are available in the literature about the determination of OTC residues in different matrices of food-producing animals by high-performance liquid chromatography (HPLC) with fluorescence detection. On the other hand, only a few studies have been carried out in vegetables (Oka, Ito, & Matsumoto, 2000). The use of mass spectrometric techniques also have been applied to the analysis of OTC residues in animal origin foods (Oka, Ito, Ikai, Kagami, & Harada, 1998).

Several reports are available about the decline of pesticide residues on food materials and the investigators have found that these active ingredients decrease with time or by various culinary applications, depending on the type and properties of the pesticides (Gambacorta, Faccia, Lamacchia, Di Luccia, & La Notte, 2005).

Cengiz et al. (2007) investigated the residue quantities of the pesticides captan and procymidone in tomato samples comparing the cultivation in two different greenhouses and culinary applications. Greenhouses are framed structures covered with transparent or translucent material and large enough to grow crops under partial or fully controlled environmental conditions to get maximum productivity and quality produce (Mahajan & Singh, 2006). The same authors also studied the residue contents of the pesticides DDVP (dichlorvos) and diazinon applied on cucumbers grown in greenhouses and their reduction by duration of the pre-harvest interval and post-harvest culinary applications (Cengiz, Certel, & Göçmen, 2006).

Another study was undertaken by Gambacorta et al. (2005) to evaluate the decline of the pesticide residues (benalaxyl, chlorothalonil and methomyl) in a variety of processing tomato grown in open field. The authors Zhang, Liu, Yu, Zhang, and Hong (2007) developed a multi-residual method to determine the dynamics of the pesticides (chlorpyrifos, dimethoate, cyhalothrin, cypermethrin, fenvalerate, delthamethrin and chlorothalonil) in the spring cabbage grown in the open field. The results of these studies showed that some pesticides residues were reduced by the pre-harvest intervals and/or culinary applications, such as washing, peeling and storage.

Studies and information comparing the antibiotic residue decline in some vegetables grown in open field and greenhouse at the same time, including the tomatoes, are lacking. Then, a study was undertaken to evaluate the decline of the residues of OTC in tomatoes grown in open field and greenhouse.

In view of the importance of this crop, this study seems necessary and the present work reports the results of an investigation which aims to describe the residual behaviour