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RESEARCH ARTICLE

Risk assessment and ranking of pesticide residues in Chinese pears

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Abstract

The presence of pesticide residues in pears is a serious health concern. This study presents the results from a 2-year investigation (2013–2014) that used gas chromatography, GS/MS and UPLC/MS-MS to measure the levels of 104 pesticides in 310 pear samples. In 93.2% of the samples, 43 pesticides were detected, of which the maximum residue levels (MRLs) were exceeded in 2.6% of the samples. Multiple residues (two to eight compounds) were present in 69.7% of the samples; one sample contained nine pesticides and one sample contained 10. Only 6.8% of the samples did not contain residues. To assess the health risks, the pesticide residue data have been combined with daily pear consumption data for children and adult populations. A deterministic model was used to assess the chronic and acute exposures based on the Joint Meeting on Pesticide Residues (JMPR) method. A potential acute risk was demonstrated for children in the case of bifenthrin, which was found to be present at 105.36% of the acute reference dose (ARfD) value. The long-term exposure of the Chinese consumer to pesticide residues through the consumption of raw pears was far below the acceptable daily intake (ADI) criterion. Additionally, the matrix ranking scheme was used to classify risk subgroups of pesticides and pear samples. In general, 95.5% of samples were deemed to be safe and nine pesticides were classified as being of a relatively high risk. The findings indicated that the occurrence of pesticide residues in pears should not be considered a serious public health problem. Nevertheless, a more detailed study is required for vulnerable consumer groups, especially children. Continuous monitoring of pesticides in pears and tighter regulation of pesticide residue

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standards are recommended.

Keywords: pear, pesticide residue, risk assessment, intake, risk ranking

1. Introduction

Pesticides are commonly used in agricultural production for pest control, fungal disease eradication and weed control. They are used not only during crop growth, but also during post-harvest treatment. The proper use of pesticides may improve the quantity and quality of crops. However, increased use of chemical pesticides has resulted in contamination of the environment and also caused many associated adverse health effects (Pedlowski *et al.* 2012; Skretteberg *et al.* 2015). Nowadays, surveillance programs worldwide require the measurement of pesticide residues in agricultural products to protect consumer health, improve the management of agricultural resources and prevent economic losses. Pesticide residue monitoring is considered as the only tool to control the quantity of pesticides in agricultural products. For the past few decades, regulatory authorities in many countries have established monitoring systems for agricultural products and the environment. The surveillance focuses on the proper use of pesticides in terms of authorization and registration, and on compliance with maximum residue limits (MRLs). Nowadays, more studies tend to assess the systemic risk.

The presence of pesticide residues in fruits and vegetables has always been a matter of serious concern in many countries (Bempah *et al.* 2011; Chen *et al.* 2011; Bakırcı *et al.* 2014; Szpyrka *et al.* 2015). In most studies, risk assessment was conducted on a wide variety of fruits and vegetables. Chen *et al.* (2011) evaluated the pesticide residues in 3 009 samples of five fruits and 16 vegetables collected from the city of Xiamen, China from 2006 to 2009 and found a low contamination level. Szpyrka *et al*. (2015) analyzed pesticide residues in 1 026 samples of fresh fruits and vegetables from southeastern Poland. The results indicated that the exposure risk was not a health concern and was much lower than 100% of the acceptable daily intake (ADI) or 100% of the acute reference dose (ARfD). The occurrence and dietary exposure assessment of ethylenethiourea in apple, papaya and strawberry were reported and showed a low potential risk (Lemes *et al.* 2014). Moreover, studies on risk perception often show that consumers view pesticides as a very high risk whereas the actual risk, viewed against other hazards, is low (Harris *et al.* 2001).

Pears are one of the most common and popular fruits consumed in China. Pears are a good source of vitamins, minerals, fiber, antioxidants and other beneficial ingredients (Chen *et al.* 2007; Li *et al.* 2014). According to official statistics (NBSC 2013), pear production amounted to 17.1 million tons in 2012 and was the third largest fruit crop in China. As mainly consumed raw in China, pesticide residue in pears need to be paid highly attention to. However, risk assessment conducted on pears exclusively has not been reported in either China or abroad. And clearly, this is required.

The aim of the present study was to determine the levels of pesticide residue in pears grown in China and to assess whether the residues pose a health risk to the local consumer. Furthermore, a preliminary classification involving matrix-ranking subgroups for pesticide residues and pear samples was performed.

2. Results

2.1. Pesticide residues

A total of 310 fresh pear samples from Chinese orchards were analyzed. Twenty-one samples (6.8% of all tested samples) were residue-free and 289 (93.2%) were found with pesticide residues, of which 281 (90.6%) contained pesticide residues at or below the MRLs established by Chinese legislation (GB 2763-2014 2014) and eight samples (2.6%) contained pesticide residues above the MRLs. In terms of the co-presence of pesticide residues, the combination of one or two fungicides and one or two insecticides was frequent. 218 samples (70.3% of positive samples) contained more than one pesticide residue, one sample contained nine compounds, and one contained 10 compounds (Fig. 1).

In the analyzed samples, 43 different pesticides were found (Table 1). Insecticides were the main pesticide residue found in pears (48.8%), followed by fungicides (37.2%). Acetamiprid, carbendazim and cyhalothrin were the most frequently detected pesticides but their concentrations were below the MRLs. Residues of cyfluthrin, profenofos, pyrimethanil and tebuconazole in one sample, as well as difenoconazole and omethoate in two samples, respectively, exceeded the MRLs. However, the distribution of pesticide residues indicated that for most samples (70.0%), residues were at low concentrations of the order of 0.001–0.050 mg kg^{-1} (Fig. 2). The highest concentration of a pesticide residue was 1.90 mg kg^{-1} pyrimethanil in a sample from Jiangsu Province, China.