Pesticide Residue in Tea and its Risk Assessment

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Outside of water tea is the most consumed beverage in the world. It is also recognized as one of the most popular healthy drink in 21st century. The viewpoint of tea drinking is beneficial to human health was accepted by the consumers. The safety quality was paid more attention by the consumers all over the world. For the purpose of control of tea pests in the tea production, chemical pesticides are applied. Due to the following aspects, the residue level on/in tea plant is much higher than that on/in other crops under the same applied dosage.

- ★ **The harvest portion of tea plant (tea shoot) is the pesticide direct applied portion.**
- ★ **Tea shoot with tender and thin leaves, the surface area per unit weight of tea plant is larger than that of other crops including the vegetable crops.**
- ★ **Tea plant is a crop that harvested multi-times annually, the interval days between the pesticide application and tea plucking is shorter than other crops.**
- ★ **The tea fresh leaves are directly manufactured after plucking and without washing.**

1. Present situation

As with other crops, control of pests by chemicals is widely used in tea production. However, due to the above mentioned characteristics that different from other crops, the suitable pesticides used in tea production is somewhat different from the pesticides used in other crops. That is high efficiency to target pests, low acute toxicity, easy to degrade under natural condition, no taint to tea aroma. Up to now, the popular chemical pesticides used in tea production are as follows： Endosulfan，Imidacloprid > Bifenthrin, Cypermethrin > Deltamethrin >Acetamiprid> Propagite. According to the results of determination on China tea sample (around 50,000 tea samples), those pesticides that higher than the MRL standards of EU are as follows: Fenvalerate > Fenpropathrin > Imidacloprid > Acetamiprid. However, the percentage of tea samples that higher than the MRL standards issued by EU was decreased significantly in recent years.

Octachlorodipropyl ether (S421) is a pesticide synergist, mainly used in the manufacture of pyrethroid pesticides. According to the determination of tea samples, it was found that the percentage of tea samples that higher than the MRL standard of tea issued by EU (MRL of S421 in tea is 0.01 mg/kg) was as high as more than 30% during the period of 2004—2007. Research indicated that the S421 residue in tea samples was come from the absorption of volatiles of S421 by tea. Where is the S421 come from? According to the investigation in my Institute, it was discovered that the S421 was come from the mosquito-repellent coil products. We collected different mosquito-repellent coil samples from the market, it was found that all the 24 mosquito-repellent coil samples and 6 mosquito spraying aerosol samples contained S421 residue, from 0.78-27.66 mg/kg in mosquito-repellent coil samples and

0.011-1150.8 mg/kg in mosquito spraying aerosol samples. The following results were obtained in the investigation:

1. **The volatile of S421 in the room degrades to lower than 0.01 mg/kg within 72 hrs. The HL50 of S421 in tea leaves is around 0.86 days and HL50 in the soil is around 1.42 days.**
2. **The dry tea sample (S421 is not detected) could adsorb the volatiles of S421 from the air in the room condition. The tea samples could contain 0.024---0.028 mg/kg S421 after putting into the room where lighted a mosquito-repellent coil before 2-7 hr.**
3. **When the tea sample was put in the room where a mosquito-repellent coil lights. The distance between the mosquito-repellent coil and the tea samples was 10 cm to 4 M. All the tea samples contained 0.011---0.066 mg/kg S421.**
4. **When the tea samples put into the room for 6 hrs where used the mosquito spraying aerosol before 15 minutes, the tea samples contained 0.01-11.27 mg/kg S421.**
5. **According to the results of investigation, the residue of S421 in tea samples was come from the mosquito-repellent coils lighted in the workshop .**

After the investigation was completed, we write a report to the Ministry of Agriculture, and recommended to ban the use of S421 as a synergist of pyrethroid pesticide. The Ministry approved this recommendation and issued a document to ban to add this compound to any mosquito coil and spraying aerosol products since Jam. 1 of 2008. After that the percentage of tea samples that contained the S421 higher than 0.01 mg.kg was decreased rapidly. The percentage of tea samples contained S421 higher than 0.01 mg/kg was decreased from 36% in 2007—2008 to 6% in 2009. It showed that in solving the contaminant in the food sample, the most important thing is to make clear the source of contamination.

During the past 11 years, China Government paid more attention on minimizing the residue level of pesticides and heavy metals in tea, and get very obvious results.

2. The Risk Assessment of Pesticide Residue in Tea

However, in comparing with other vegetables and food crops, the consumptive style is quite different between them. In the ordinary situation, it is eaten in their entirely, but tea, with very few exceptions, is not eaten as opposed to used to make an infusion in water. Thus, consumers are not eating the tea leaves instead of drink the infusion of tea leaves. Of primary concern from the viewpoint of safety for consumers, how many amounts of agrochemicals in the tea infusion are taken in via tea drinking, not the amounts of agrochemicals in tea leaf.

As pointed out by the experiment, the amounts of agrochemicals in the infusion are not directly related with the residue level of different agrochemicals in tea leaf, but it is closely related with the water solubility of agrochemicals (Table 1).

So ,if a tea sample contains one mg/kg of residue of five pesticides with different water solubility, let's make the tea infusion with traditional method, then the difference of pesticide residue in the infusion betwe4en these five pesticides will be more than 327 times (Table 2).

TAB LE 1 Relation between percentage extraction of some pesticides in tea infusion from processed tea and water solubility of pesticides

Pesticide	Water solubility (mg/ l)	Extractability of pesticide during infusion process (%)
pp – DDT	**0.001**	**1**
Cyhalothrin	**0.005**	**2.9**
Permethrin	**0.040**	**2.9**
Cyperme thrin	**0.041**	**1.8**
Dehamethrin	**0.1**	**1.2**
Dicofol	**0.1**	**2.2**
gamma-BHC	**7.0**	**6.5**
Quinalphos	**22.0**	**40.4**
Fenitrothion	**30.0**	**70.9**
Malathion	**150**	**86.3**
Dimethoate	**25000**	**98.3**

TABLE 2 Pesticide residue in tea brew infused from dry tea

Pesticide	Residue level in dry tea (mg/kg)	Water solubility of pesticide (mg/l)	Residue level in tea brew (ng/l)	Extracting rate of pesticide (%)
DDT	**1**	**0.001**	**9.5**	**<1**
Endosulfan	**1**	**0.3**	**54.2**	**1.6-2.05**
Chlorpyrifos	**1**	**2.0**	**273.6**	**9.1**
Malathion	**1**	**150.0**	**2327.0**	**74.9-86.3**
Dimethoate	**1**	**25000.0**	**2949.0**	**93.4-98.3**

Nowadays, the determination of residues in food and beverages are determined on the basis of an analysis of the raw materials regardless of whether they are eaten or not. In the FAO working Group on tea, it is the opinion that the basis in the establishment of MRL of pesticide in tea and the analytical methods used to identify the presence of pesticides in tea needs to be revised, so to provide a more clearer understanding on the potential risk of different pesticides in tea and a more rational MRL standard for different pesticides. I think that the analysis on the tea brew will give the consumers more correct and direct information on a little risk on chemical in tea brew via the tea drinking instead of the vague information get from the dry tea.

So，In the risk assessment of pesticide residue in tea, we used the following equation to make the risk assessment of pesticide residue in tea:

$$IESTI = \frac{LP \times HR\text{-}P \times ER}{BW\ (kg)}$$

IESTI㈼International Estimate Short-Term Intake): is the international estimate of short-term intake of pesticide

LP: 97.5 point，the highest amounts of tea used for drinking per day(13 g/d)；

HR-P: Highest residue if tea after manufacture（mg/kg）;

BW: Average body weight of adult(60 kg);

ER: Maximun extracting percentage of pesticide during tea □nfusion.

Example 1 :Endosulfan

〈4〉 Highest amounts of tea used for drinking per day(13 g/d)

〈2〉 Highest residue in tea after manufacture (HR): According to the 12 experiments conducted in Hangzhou, Changsha and Anxi （600times dilution,7days after the ordinary dosage, HR= 7.87mg/kg）;

〈3〉 Maximun extracting percentage of pesticide during tea infusion(21 experiments, maximum value: 13.15%);

〈4〉ADI (According to the FAO/WHO and EU) 0.006mg/kg/

$$IESTI = \frac{0.013\ kg \times 4.31\ mg/kg \times 9.73\%}{60\ kg}$$

= 0.000091（mg/kg/d

This value is only 1 / 65.9 of Endosulfan ADI value 0.006 mg/kg.d .

Example 2 :Imidacloprid

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$$IESTI = \frac{0.013\ kg \times 1.998\ mg/kg \times 11.68\%}{60\ kg}$$

$$= 0.000051\ mg/kg/d$$

〈4〉 Highest amounts of tea used for drinking per day(13 g/d)

〈2〉 Highest residue in tea after manufacture (HR): According to the 8 experiments conducted in Hangzhou, Changsha and Anxi （600 times dilution,7days after the ordinary dosage, HR= 1.998mg/kg）;

〈3〉 Maximun extracting percentage of pesticide during tea infusion(9 experiments, maximum value: 11.68%);

〈4〉ADI (According to the FAO/WHO and EU) 0.06mg/kg/

This value is only 1 / 1176 of Imidacloprid ADI value 0.06 mg/kg.d . So, it is safe to uae in tea production.

Example 2 :Dimethoate

$$IESTI = \frac{0.013\ kg \times 0.76\ mg/kg \times 75.2\%}{60\ kg}$$

$$= 0.00012\ mg/kg/d$$

〈4〉 Highest amounts of tea used for drinking per day(13 g/d)

〈2〉 Highest residue in tea after manufacture (HR): According to the 9 experiments conducted in Hangzhou, Changsha and Anxi （600 times dilution,7days after the ordinary dosage, HR= 0.76 mg/kg）;

〈3〉 Maximun extracting percentage of pesticide during tea infusion(9 experiments, maximum value: 75.2.%);

〈4〉ADI (According to the FAO/WHO and EU) 0.002mg/kg/

This value is only 1 / 16.6 of Dimethoate ADI value 0.002 mg/kg.d . So, it is dangerous to uae in tea production.

Reference

1 中国农业科学院农业质量标准与检测技术研究所，2007， 农产品质量安全风险评估---原理、方法和应用，第三部分，农产品中农药残留风险评估现状及应用，，中国标准出版社

2．中华人民共和国农业部公告 第 747 号， 2006 年 12 月 6 日

3．Committee on Commodity Problems, Intergovernmental Group on Tea, 19th Session,2010, CCP:TE 10/CRS 18, Transferring rate and risk assessment of pesticide residue from dry tea to tea brew and the significance in establishing the pesticide MRL in tea.

4 Wan Haibin, CHEN Zongmao, 1991, Extraction of pesticide residues in tea by water during the infusion process, Food Addit. and Contam. 8(4)497-500