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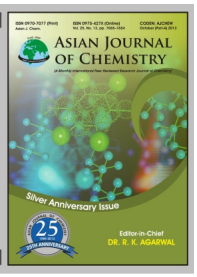

Absorption Spectra of Pesticide Residue about Imidacloprid in Fruit Juices

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The absorption spectra of imidacloprid and the mixed system of imidacloprid and juice (apple, orange and peach juice) were studied. The experimental results show that the most intensive characteristic peak (269 nm) was found in the spectrum of standard solution of imidacloprid. With the increasing amount of imidacloprid in apple juice, absorbance of mixed solution of apple juice and imidacloprid was improved gradually and the phenomenon of blue shift was found about the peak position which was decreased from 281 to 269 nm. Then we obtain the prediction model between the peak wavelength or absorbance and the content of imidacloprid ($r^2 > 0.99$). And the prediction model of imidacloprid content were obtained in orange and peach juice through the same process and the coefficient of determination orange juice was 0.97911 and the coefficient of determination of peach juice was 0.96764. The result proved that it is possible to detect pesticide residues of imidacloprid in fruit juice and it can meet the needs of rapid analysis.

Key Words: Fruit juices, Imidacloprid, Absorption spectrum, Pesticide detecting.

INTRODUCTION

Imidacloprid is a systemic insecticide which acts as an insect neurotoxin and belongs to a class of chemicals called the neonicotinoids which act on the central nervous system of insects [1]. The pesticide residues resulting from extensive use of imidacloprid in agricultural production must be dangerous to consumers. People usually focus on the impact on the environment or agricultural[2-5], while ignoring the detection of pesticide residues for agro-processing products, for example a variety of juice or children jam. We should not ignore the pesticide residues in such products because of the most consumer groups of such products are children whose resistances are weak and are more vulnerable to the harm of pesticide residues.

There are many kinds of analysis methods about the pesticide residue detection, for example gas chromatography, thin layer chromatography, high performance liquid chromatography, gas or liquid chromatography - mass spectrometry and biochemical assay, *etc*.[6-11]. There are some shortcomings about these methods, such as more consumption of reagents, complicated sample pre-treatment process, *etc*. The paper mainly introduces the detection and research of imidacloprid pesticide residue in pure apple, orange and peach juice through the spectrophotometer and the experimental study of absorption spectral characteristics of imidacloprid in these pure fruit juice.

EXPERIMENTAL

Apple juice, peach juice, orange juice (100 %) and pure water were purchased from large supermarket (Nanjing China). Imidacloprid was obtained from Jiangsu Provincial Academy of Agricultural Sciences (Nanjing, China).

The absorption spectrum was recorded by using a UV-3600PC spectrophotometer (Shimadzu, Japan) equipped with 1.0 cm quartz cell. The measurement system uses a double optical path. Because the dual beam instrument can overcome the errors caused by the single beam instrument since the unstable light source and can scan the whole band.

Procedures: Imidacloprid was diluted the standard drug solution of different concentration (0.072, 0.036, 0.018 and 0.009 mg/mL) using pure water. The absorption spectrum of various solutions was obtained through the UV-3600. Then the pure apple juice was diluted by pure water in accordance with the volume ratio of 1:3 and peach juice, orange juice was diluted, respectively by pure water with the volume ratio of 1:15, then their absorption spectrums were obtained through the UV-3600. Three juices (2.5 mL) were taken using cuvette, respectively and the imidacloprid standard solution (0.036 mg/mL) was mixed with the three juices by successive addition from 0.2 to 1.0 mL. After sufficiently stirred, the fruit juice and drug solution should be mixed well and their absorption spectrums were obtained.

RESULTS AND DISCUSSION

Absorption spectrum of imidacloprid: Fig. 1 shows the representative standard curve of absorption spectrum about imidacloprid standard solution. The spectral range is 220-700 nm and the abscissa indicates the light wavelength while the ordinate indicates absorbance. In addition, the imidacloprid solution is corresponding to 0.072, 0.036, 0.018 and 0.009 mg/mL from curve 1-4. As can be seen that there is a strong absorption peak at 269 nm and the peak is also reduced from 5.2 to 0.9 with the decrease of concentration. So the 269 nm can be used as the characteristic peak of imidacloprid absorption spectrum.

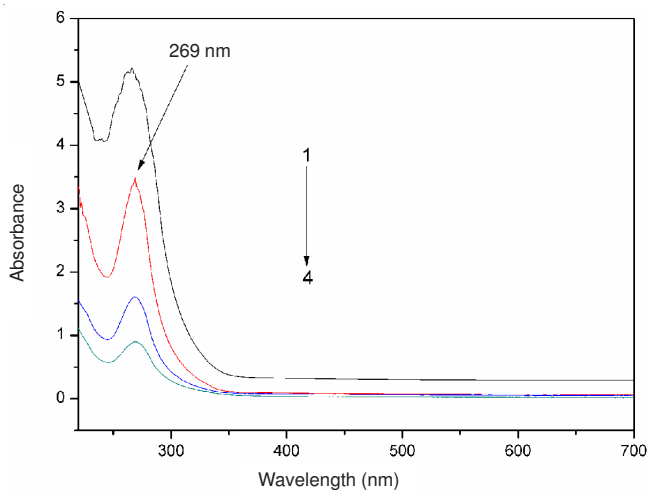

Fig. 1. Absorption spectrum of imidacloprid of different concentration (the imidacloprid solution corresponding to 0.072, 0.036, 0.018 and 0.009 mg/mL from curve 1-4)

Absorption spectroscopy of imidacloprid and apple juice: Fig. 2 shows the UV absorption spectra of apple juice and imidacloprid and the curve of 1 and 7 represents the absorption spectra of apple juice and imidacloprid (0.036 mg/mL). In addition, the curve from 2 to 6 is corresponding to 0.2, 0.4, 0.6, 0.8 and 1.0 mL about the imidacloprid solution (0.036 mg/mL), respectively which is added in the apple juice. It is seen that there are some changes about the absorption peak and the absorbance with the increase of imidacloprid, which is shown in Fig. 2(a). Moreover absorption peak was undergone blue shift (12 nm) from 281 to 269 nm, while the absorbance was increased from 1.902 to 2.497. It indicates that there is a chemical reaction between imidacloprid and apple juice, which makes the absorption peak move to the short wavelength because of the unshared electron pair groups coming from the chemical reaction. So its absorbance is not a superposition of single imidacloprid and apple juice. The absorption spectrum peak (269 nm) of the mixed solution and imidacloprid is coincident when imidacloprid is added to 1 mL. We can also find that, relative to imidacloprid absorption

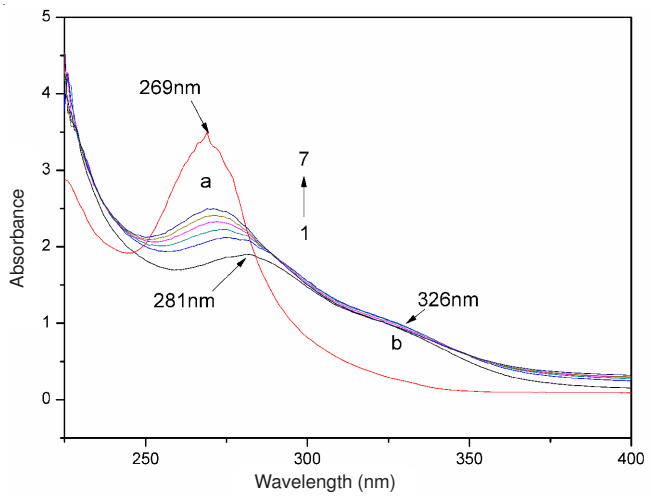

Fig. 2. Absorption spectrum of mixed solution of apple juice and imidacloprid [1: Apple juice, the imidacloprid solution is corresponding to 0.2, 0.4, 0.6, 0.8, 1.0 mL from curve 2-6 in apple juice; 7: Imidacloprid solution (0.036 mg mL^{-1})]

spectrum, imidacloprid-juice mixed solution exist a acromion centered at 326 nm in Fig. 2(b) which should be the absorption peak of the apple juice itself.

In order to further study the relationship between the peak of absorption spectrum of apple juice-imidacloprid mixed solution and the content of imidacloprid, we obtain the mixed solution concentration about the imidacloprid after conversion and corresponding peak wavelength and absorbance, which are shown in Table-1. In order to obtain the prediction model, we execute the exponential fitting between the content of imidacloprid and the peak wavelength of the absorption spectra, absorbance, respectively by using Origin, which is shown in Fig. 3.

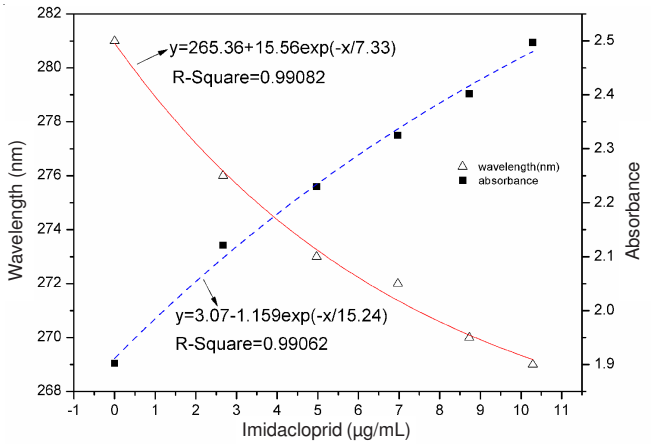

Fig. 3. Relationship between the content of imidacloprid in apple juice and the peak of absorption spectrum, absorbance

Absorption spectroscopy of imidacloprid and orange, peach juice: The absorption spectra of the mixture of orange

TABLE-1
PEAK OF WAVELENGTH AND ABSORBANCE WITH DIFFERENT CONTENT OF IMIDACLOPRID IN APPLE JUICE

Imidacloprid (μg/mL)	0	2.67	4.97	6.97	8.73	10.29
Peak wavelength (nm)	281	276	273	272	270	269
Absorbance	1.902	2.121	2.23	2.325	2.402	2.497

juice and peach juice with imidacloprid standard solution were obtained through the same experimental procedure (Figs. 4 and 5). The curve of 1 and 7 represents the absorption spectrum of pure juice and imidacloprid (0.036 mg/mL), respectively. In addition, the curve from 2 to 6 is corresponding to 0.2, 0.4, 0.6, 0.8 and 1.0 mL about the imidacloprid solution (0.036 mg/mL) which is added in both juices, respectively. The absorbance of mixed solution of both juices-imidacloprid at 269 nm is increased gradually with the increase of the content of imidacloprid through comparing Fig. 4A(a). On comparing with the apple juice, we cannot find the blue shift phenomenon, which shows that the peach juice and orange juice don't interact with imidacloprid and the absorption spectrum is the superimposed of juice and imidacloprid. It is obvious that the absorbance is declined with the increase of imidacloprid in Figs. 4A(b) and 5(b), which is opposite comparing with the mixed solution of apple juice and imidacloprid.

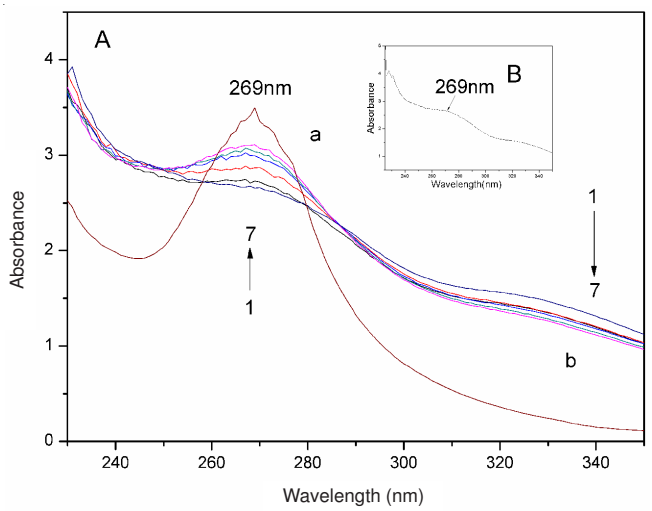

Fig. 4. Absorption spectrum of mixed solution of orange juice and imidacloprid [1: Orange juice; The imidacloprid solution is corresponding to 0.2, 0.4, 0.6, 0.8, 1.0 mL from curve 2-6; 7: Imidacloprid solution(0.036 mg mL^{-1})]

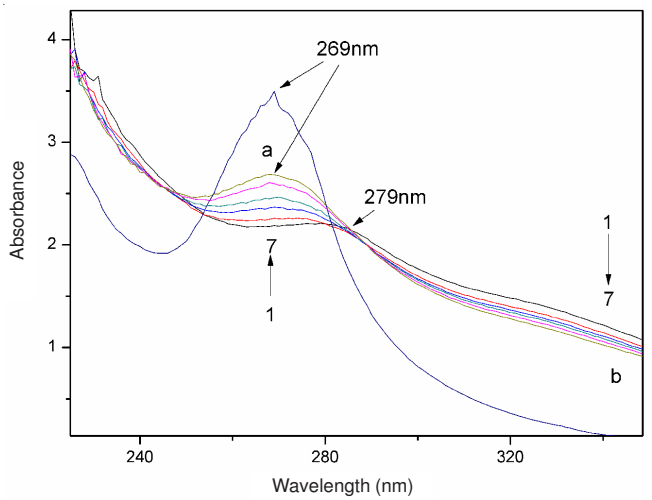

Fig. 5. Absorption spectrum of mixed solution of peach juice and imidacloprid [1: Peach juice; The imidacloprid solution is corresponding to 0.2, 0.4, 0.6, 0.8, 1.0 mL from curve 2-6; 7: Imidacloprid solution (0.036 mg mL^{-1})]

Fig. 4(B) indicates the absorption spectrum of orange juice and we can find it has been on the decline and don't exist the absorption peak at 269 nm, but the downward trend becomes slowly. Moreover the absorption peak is found about the absorption spectrum of peach juice at 279 nm (Fig. 5). So we can analyze the pesticide residue of imidacloprid by using the characteristic peak of absorption spectrum at 269 nm in orange juice and peach juice.

In order to further study the correlation between the absorbance and the content of pesticide, the concentration of imidacloprid was obtained according to the corresponding dose of imidacloprid after calculation. The concentration of imidacloprid and the absorbance at 269 nm are shown in Table-2.

The prediction models of the absorption spectrum and the content of pesticide are obtained through the method of least squares about the absorbance and content of imdacloprid of both juices at 269 nm using Origin 8.0, which are shown in Fig. 6. It is found that the relationship between the absorbance and the content of imidacloprid is fine at 269 nm according to the curves and functional model. The coefficient of determination of orange juice is 0.97911, while the coefficient of determination of peach juice is 0.96764.

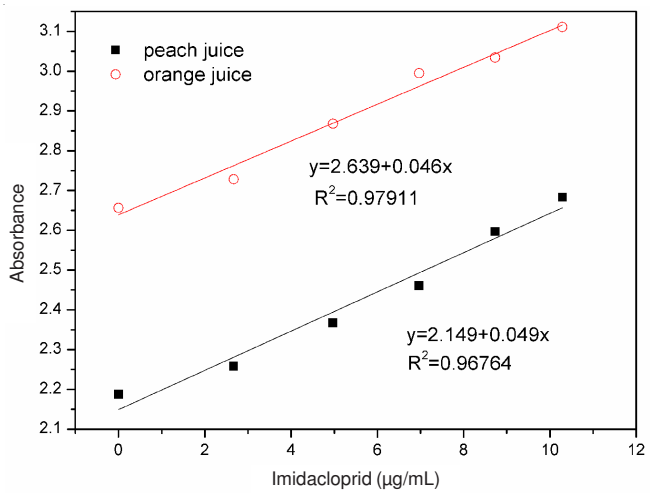

Fig. 6. Curve between the absorbance at 269 nm and the content of imidacloprid

Conclusion

The content of imidacloprid in apple juice, orange juice and peach juice were detected by using spectrophotometer. The experimental results show that there were obvious characteristic peaks at 269 nm about imidacloprid standard solution of different concentration and with the increase of concentration of pesticides, the characterized peak value was also increased. So we can use this characteristic peak to detect the content of imidacloprid in fruit juice.

The standard solution of imidacloprid (0.036 mg mL^{-1}) was added in pure apple juice, then the absorption spectrum of apple juice-imidacloprid mixed solution was obtained. The results show that the peak of absorption spectrum exits the blue shift with the increase of the imidacloprid in apple juice.

The prediction models of the content of imidacloprid and the wavelength of characterized peak and the corresponding

TABLE-2
ABSORBANCE WITH DIFFERENT CONTENT OF IMIDACLOPRID PESTICIDE IN JUICE

Imidacloprid (μg/mL)	0	2.67	4.97	6.97	8.73	10.29
Absorbance (orange juice)	2.656	2.728	2.868	2.995	3.034	3.111
Absorbance (peach juice)	2.188	2.258	2.367	2.461	2.597	2.683

absorbance were obtained through the function fitting using Origin 8.0 and the coefficient of determination was 0.99082 and 0.99062, respectively. The standard solution (0.036 mg mL^{-1}) was added in orange juice and peach juice and the obvious absorption peak was found at 269 nm. We could also obtain the prediction models of the content of imidacloprid and the absorbance and the coefficient of determination was 0.97911 and 0.96764, respectively. Comparing with the existing detection methods, the absorption spectroscopy method for the direct detection and analysis of imidacloprid in fruit juice is more rapid and effective.

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