The Variation of Pesticide Residues in the Processing of Mango Juice

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Abstract. In order to study the effect of different processing methods on pesticide residues in the mango juice. Different processing, namely, washing, peeling, beating, sterilization and cooling were treated to clarify the changes of pesticides (prochloraz, carbendazim, thiophanate-methyl and its metabolite 2-amino benzimidazole) in mango juice. The results showed that the processing factors were less than 1 in mango juice processing. Clean and peel play an important role in mango juice. It can remove the vast majority of pesticides basically. The change trend of four kinds of pesticides is similar in the process of beating, sterilization and cooling, showing the tendency of decrease firstly and then increase again, so pesticide were degraded and transformed partially in this process.

Introduction

Mango is the world's second largest tropical fruit after bananas. The use of pesticides is essential in order to ensure the yield of mangoes all over the world[1]. Nowadays, fruit juices are consumed daily in the European Union (EU) countries, due to their high nutritious values and to its benefits on the human health[2]. The long-term selection process imposed to improve mango fruit productivity has made mango crops less resistant to diseases, pests, and adverse environmental conditions[3]. Excessive pesticide use can pose a threat to human health and the environment[4]. Pesticide residues in fruits are an important issue in terms of food safety at present. EU regulation does not set specific MRLs for juices, and so, MRLs of the raw product are applied in the cases of processed food[5]. Pesticide residue levels found in fruit juices depend on various factors such as type of pesticide, commodity, treatment applied, processing methods and degradation processes involved[6]. In order to study the effect of different processing methods on pesticide residues in the mango juices. Different processing were treated to clarify the changes of pesticides in mango juices. The purpose of the study is to determine the changes in pesticide residues in the processing of mango juice, to provide scientific data on dietary exposure assessment based on mango juice, to take some measures to reduce pesticide residues and to ensure the safety of mango juice.

Materials and Methods

Materials and Reagents

Experiments were performed on mangoes, and picked at a local mango cultivation base in Guangdong Province. The standards substance were acquired from the Ministry of Agriculture Environmental Monitoring Research Institute in China, concentrations are 100μg/mL. Analytical grade of all chemicals used in this investigation were purchased from Guangdong Guanghua Science and Technology Co., Ltd. Pesticides were purchased from local companies in China.
The Processing of Mango Juice

Experiments through access to literature and related information, the processing of mango juice as followed. Choose fresh mango as raw material, cleaned by tap water, peeled by hand. According to mango: water (1: 3) ratio of water beating, and a small amount of Vc was added to protect the color of mango. And then the deployment of the mango juice into a sterile bottle, placed in the environment at 4℃ cold standby. The prepared mango juice is put into the temperature of 60℃ to 70℃ for 5 minutes to 10 minutes to destroy the pectin. Finally, remove the mango juice cooled to room temperature after sterilization.

Pretreatment and Detection Methods

Detection methods reference GB/T 20769-2008 "Determination of 450 pesticide residues and related chemicals residues in fruits and vegetables-LC-MS-MS method" detecting pesticide residues in mango juice processing, method were modified slightly.

Experimental Conditions of UPLC. The type of column is ACQUITY UPLC®BEH C18 1.7μm. The injection volume was 2μL. The mobile phase gradient elution conditions were as shown in Table 1.

<table>
<thead>
<tr>
<th>Time/min</th>
<th>Flow/mL·min⁻¹</th>
<th>Acetonitrile V/V, %</th>
<th>0.1 % Formic water V/V, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.300</td>
<td>5.0</td>
<td>95.0</td>
</tr>
<tr>
<td>0.20</td>
<td>0.300</td>
<td>5.0</td>
<td>95.0</td>
</tr>
<tr>
<td>1.00</td>
<td>0.300</td>
<td>95.0</td>
<td>5.0</td>
</tr>
<tr>
<td>3.00</td>
<td>0.300</td>
<td>95.0</td>
<td>5.0</td>
</tr>
<tr>
<td>3.10</td>
<td>0.300</td>
<td>5.0</td>
<td>95.0</td>
</tr>
<tr>
<td>5.00</td>
<td>0.300</td>
<td>5.0</td>
<td>95.0</td>
</tr>
</tbody>
</table>

Mass Spectrometry Conditions. Pesticide are electron impact ionization positive ion scanning mode (ES+). Capillary voltage 0.5kV. Ion source temperature 150℃. Solvent temperature 600℃. The solvent gas are high purity, the flow rate was 1000L/h and 150L/h, respectively. Quantitative ion pair, qualitative ion pair, cone hole voltage and collision energy were shown in Table 2. (*Quantitative ions)

<table>
<thead>
<tr>
<th>compound</th>
<th>Parent ion (m/z)</th>
<th>Daughter ion (m/z)</th>
<th>Cone (V)</th>
<th>Collision (eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>thiophanate-methyl</td>
<td>343.00</td>
<td>151.00*</td>
<td>19.00</td>
<td>46.00</td>
</tr>
<tr>
<td></td>
<td>192.10</td>
<td>132.10</td>
<td>24.00</td>
<td>20.00</td>
</tr>
<tr>
<td>carbendazim</td>
<td>160.10*</td>
<td>24.00</td>
<td>18.00</td>
<td></td>
</tr>
<tr>
<td>2-amino benzimidazole</td>
<td>134.10</td>
<td>79.80</td>
<td>35.00</td>
<td>25.00</td>
</tr>
<tr>
<td>procloraz</td>
<td>376.00</td>
<td>91.80*</td>
<td>35.00</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Data Processing

Degradation rate:

\[
\text{Degradation rate} = \frac{P_0 - P_1}{P_0} \times 100\% \quad (1)
\]

Processing Factor:

\[
F = \frac{F_1}{F_0} \quad (2)
\]

Above is the commonly used formula in this experiment. In the announcement (1), \( P_0 \) is the initial residual amount of the preservative agent before the processing of mango (μg/kg), and \( P_1 \) is the residual amount after treatment (μg/kg). In the announcement (2), \( F_1 \) is the residual amount after mango processing (μg/kg), \( F_0 \) is the initial residue before mango processing (μg/kg).
Results and Discussion

Pesticides may undergo degradation, transformation, volatilization and concentration changes, and pesticide residues are subject to different changes in processing.

Table 3. Pesticide residues in all aspects of mango juice processing (μg/kg).

<table>
<thead>
<tr>
<th>Process</th>
<th>thiophanate-methyl</th>
<th>carbendazim</th>
<th>2-aminobenzimidazole</th>
<th>procloraz</th>
</tr>
</thead>
<tbody>
<tr>
<td>material</td>
<td>68.78±0.66</td>
<td>15.99±0.29</td>
<td>19.23±2.06</td>
<td>33.21±1.19</td>
</tr>
<tr>
<td>cleaning</td>
<td>66.75±0.64</td>
<td>14.54±0.52</td>
<td>16.13±0.71</td>
<td>26.01±1.20</td>
</tr>
<tr>
<td>peeled</td>
<td>32.09±2.39</td>
<td>5.05±1.34</td>
<td>2.43±0.08</td>
<td>0.94±0.14</td>
</tr>
<tr>
<td>beating</td>
<td>30.80±0.67</td>
<td>6.00±0.11</td>
<td>3.53±0.41</td>
<td>0.93±0.04</td>
</tr>
<tr>
<td>sterilization</td>
<td>29.20±0.62</td>
<td>5.77±0.13</td>
<td>2.87±0.19</td>
<td>0.87±0.06</td>
</tr>
<tr>
<td>cooling</td>
<td>31.25±0.21</td>
<td>6.03±0.09</td>
<td>3.04±0.11</td>
<td>0.91±0.06</td>
</tr>
</tbody>
</table>

The Impact of Cleaning on Pesticide Residues

As shown in table 3 and table 4, the cleaning could reduce the initial pesticide content in the processing of mango juice, the degradation rate of four pesticides were 2.95% 9.10%, 16.10% and 21.68%, respectively. The effect of cleaning on the degradation of pesticide residues was mainly affected by the physical and chemical properties of pesticides, such as vapor pressure and solubility. Carbendazim belong to fat-soluble pesticides, the degradation rate of 2.95%~21.68% in the tap...
water cleaning links, indicating that water cannot be a good degradation of pesticides in mango raw materials. Sonchieu J. et al[7] in the study of tomato found that the use of different cleaning liquid to clean the tomato, the degradation rate of different pesticide residues, tap water removal is poor. This is consistent with the results of this study.

The Impact of Peeled on Pesticide Residues

Pesticides are usually attached to the surface of agricultural products, so peel is the most effective way to reduce pesticide residues in agricultural products level[8]. In terms of systemic pesticides, which can penetrate the flesh inside through the epidermis, peeled not remove the mango pesticide method completely[9]. As shown in table 3 to 4, peeled on the impact of four pesticides were larger in the mango juice processing. The processing factors were 0.4665, 0.3161, 0.1265 and 0.0282, respectively. Which indicated that the peeled can remove the pesticide residues in the mango juice processing to a large extent. Carbendazim, methyl-thiophanate all belong to the absorption of the spectrum of fungicides, can through the epidermis to the flesh part of the penetration of fruit in the process of mango preservation, so the peeled can only remove part of the pesticides in mango. Because 2-amino benzimidazole and prochloraz were mainly present in the outer surface of mango. Peeling has the greatest effect on it and can be almost completely removed.

The Impact of Beating on Pesticide Residues

As shown in Table 3, the residues of methyl thiophanate and fresh amine tend to decline in the beating process, the degradation rate was 55.22%, 97.21%. The biodegradation rates of carbendazim and 2-aminobenimidazolone were increased by 62.50% and 81.65%, respectively. The reason may be thiophanate-methyl degradation of carbendazim in this process, carbendazim instability in the acidic color protection environment, further degradation of 2-amino benzimidazole, there is a certain between the three Inhibit and promote the degradation of the law, so the content of 2-amino benzimidazole and carbendazim is increased compared with that of the peeled part[10].

The Impact of Sterilization on Pesticide Residues

The sterilization conditions used is 60℃ to 70℃ for 5min to 10min in this experiment, the purpose is to destroy the original pectin and endogenous enzymes in mango. As shown in fig.1 to fig.4, the effect of sterilization on the pesticide residues showed a decreasing trend during the mango juice processing. The processing factors of four pesticide residues were 0.4245, 0.3611, 0.1495 and 0.0261, and the corresponding pesticide residues were 29.20, 5.77, 2.87 and 0.87, respectively.

The Impact of Cooling on Pesticide Residues

Mango juice in a timely manner to remove the cooling After sterilization, the final mango juice content of pesticide residues is a rebound in the cooling process. As shown in the fig.1 to fig.4, the degradation rates of four pesticide residues were 54.57%, 62.29%, 84.21% and 97.26%, the corresponding pesticide residues were 31.25, 6.03, 3.04, 0.91 μg/kg.

Conclusions

In the processing of mango juice, the processing factors were all less than 1, and the pesticide residues showed a decreasing tendency, which could reduce the final pesticide residue in mango juice after processing. Which cleaning and peeling plays an important role in the content of pesticide residues in the processing of mango juice, mango can be removed in the vast majority of pesticides. The trend of pesticide is similar in the beating, sterilization and cooling process, showed a trend to reduce and then rise again. This shows that mango juice due to the temperature rise, the transformation of the pesticides and degradation of part of the sterilization process, so four kinds of pesticide residues decreased in this session, the reason may be the temperature have a huge influences in pesticide residues of mango juice process. Therefore, we should pay attention to the impact of ambient temperature on the final pesticide residues in mango juice. Mango juice should be processed under appropriate conditions and methods.
Acknowledgement

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References


