What Pesticides Have You Eaten Today?

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Purpose of Study:

There is a lot of concern about ingesting pesticides that could be left on fruits and vegetables. Pesticides are designed to be toxic, and their effects on people aren't very well understood, so it's best to avoid them when you can. I will evaluate which fruits contain the most pesticides and if washing and peeling helps to remove them.

Hypothesis:

If a water rinse doesn't remove the pesticides, then the skin of the fruit must be retaining them.

Materials:

Assorted Fruits, peeled and unpeeled
Assorted organic fruits , peeled and unpeeled
Blender
Chemicals – water, acetonitrile (ACN), acetic acid, pesticide standards
QuEChERS kit
Mass spectrometer
Volumetric flasks and beakers
Pipettes
Analytical balance
Centrifuge
Autosampler vials
Gloves
Lab coat and eye protection

Procedure:

1. Wash one set of grapes for 30 seconds with cold water
2. Remove peel from one set of oranges, organic oranges, bananas and organic bananas
3. Cut up fruits (except grapes) and place in individual marked containers. (Figure 1)
4. Place containers in freezer overnight
5. Blend each fruit sample and place back in container, wash blender between each sample (Figure 2)
6. Weigh out 10g of each homogenized fruit and place in a 50mL conical tube. Record the weight of each sample (Figures 3 and 4)
7. Make a standard solution of 1% acetic acid in acetonitrile (v/v)
8. Add 15mL of the standard solution to each vial and an appropriate amount of pesticide internal standard
9. Add a Q-sep packet from the QuEChERS kit to each vial following the instructions in the kit
10. Shake each vial by hand for 1 minute
11. Spin down each vial in a centrifuge for 1 minute at >1,500 rcf
12. Remove 1mL from each vial and dry down under nitrogen
13. Once completely dry, add in 1mL of mobile phase (90% Water/10%ACN)
14. Filter into an autosampler vial and place into mass spectrometer
15. Calibrate instrument using pesticide standards (Figure 5)
16. Analyze for pesticides using a mass spectrometer

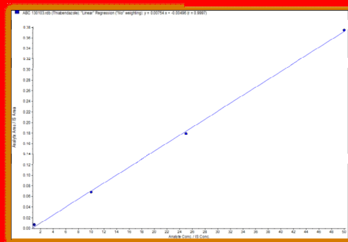


Figure 5 – Representative calibration curve

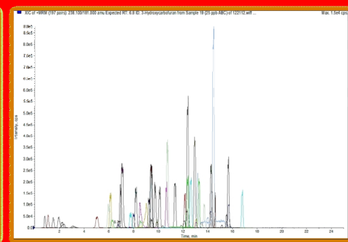
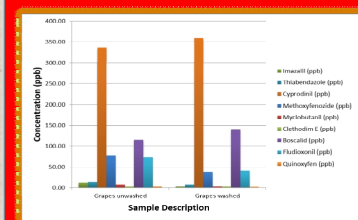
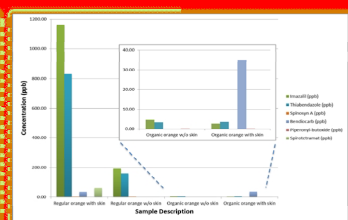


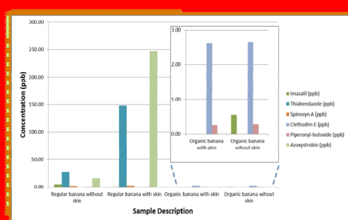
Figure 6 – Mass spectrum example



Graph 1 – Grape results



Graph 2 – Orange results



Graph 3 – Banana results

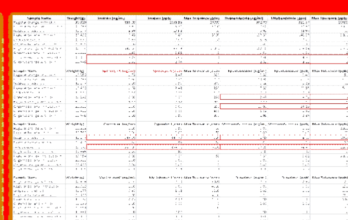


Table 1A – Pesticide concentration results

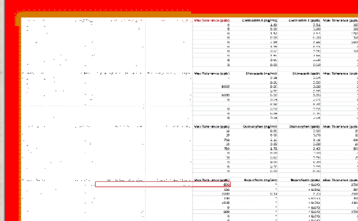


Table 1B – Pesticide concentration results

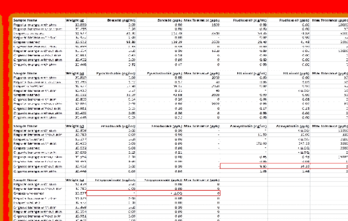


Table 1C – Pesticide concentration results

Figure 1 – Fruit separated into individual containers

Figure 2 – Homogenizing fruit with blender

Figure 3 – Weighing fruit sample on balance

Figure 4 – Transferring 10g of homogenized fruit to conical tube

Results:

A summary of the most interesting pesticides found in the fruit samples are listed in Tables 1A-C. The items outlined in red are discussed in more detail below. These tables were generated from the mass spectrometer reports (see binder). The ng/ml numbers were generated by comparing the fruit samples to the calibration curves. Figure 6 shows an example of what the raw mass spectrum looks like for a pesticide standard. The ng/ml values were converted to parts per billion (ppb) by using the weight of the fruit and a dilution of 15 mL (step 8 of Procedure). The maximum tolerances (ppb) reported in Tables 1A through C were found by searching the Electronic Code of Federal Regulations database online. A dash (-) indicates that there the pesticide is either not registered or is being reregistered. An asterisk (*) means that the pesticide was present but not assigned a value because it was below the instrument's limit of quantitation (LLOQ). All expected non organic pesticide levels fell below the maximum tolerances. The first result of interest was the detection of Imazalil, Thiabendazole, Epoxiconazole, and Azoxystrobin in the organic fruits. These pesticides are at low levels but because the fruits are organic the maximum tolerance is set at zero. Bendiocarb is a pesticide that is now banned in the US because it is toxic. A small amount was found in a few of the samples but this could be left over from an earlier spraying. Spinosyn A is approved for organic use but we did not find it in any of the organic samples. The grapes gave interesting results and are summarized in Graph 1. In Graph 1 you can see that there is not much difference between the two grape samples (especially in Cyprodinil, Methoxyfenozide, and Boscalid), this means that the washing of the grapes did not remove any of the pesticides. This fruit also contained a larger number of pesticides than the other fruits that were analyzed. Fenpryoximate was found at a low level in the unwashed grape samples. This pesticide is not registered in the United States but these grapes were imported from Peru so it is likely that the pesticide is allowed there. Graph 2 is a summary of the orange samples. Peeling of the orange definitely reduced the amount of pesticides found in the sample but it did not stop the pesticides from being adsorbed into the pulp. Imazalil and Thiabendazole were the most concentrated but from the literature review that was expected. Imazalil is a post-harvest fungicide so you would expect to see more of it than the other pesticides. Spirotetramat was found in the non-organic orange that included the skin but it is at a very low level. This is probably because it was banned for a couple years and is not widely used because it may be harmful to bees. In Graph 3 it can be seen that the peeling of the banana also made a big difference but again pesticides (Imazalil and Thiabendazole) were found in the pulp. The organic bananas contained much less pesticides and seemed to be the cleanest of all the fruits.

Conclusions:

In summary, in this study we found out that organic is not truly organic. The pesticide levels were low and way below the maximum tolerance but they were still present. Also, washing your grapes just with water does not make much of a difference. Maybe they need to be washed with something stronger than water, like soap. The peel of the oranges and bananas contained most of the pesticides so it is good that we don't eat the skins! Some recipes ask for orange and lemon zest, this most likely adds more pesticide contamination into your food. It was also found that the outer skin does not block all the absorption of the pesticides since chemicals were found in the pulp. The mass spectrometer was able to detect very low levels of chemicals, even those that had been banned or used outside the US. Be careful of imported fruits, they may contain pesticides that the USDA doesn't approve. It is still better to eat fruit than junk food but maybe we need to eat fewer grapes! Grapes, especially imported ones, are listed as part of the Dirty Dozen. In our study Grapes were the dirtiest!

Application:

This project will help people make better food choices and better understand what is going into their bodies.

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