GMO: Yes or No?  
Genetically Modified Organisms in our Food

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Abstract
Genetically modified crops have become more and more common in the last 15 years. Manufacturers are not required to say that their food is genetically modified if they use less than a certain amount of genetically modified plant foods. We tested several organic and conventional food products to see if the food samples contained genetically modified organisms (GMO). We used the polymerase chain reaction (PCR) to amplify a DNA segment that indicates genetic modification. Our hypotheses were supported by our results and we have agarose gel pictures to prove it. Some of the conventional food products tested positive for containing GMO and none of our organic food products tested positive for GMO. We bought our food products at Whole Foods Market and at Publix grocery store.

Introduction

Genetic Modification in Agriculture
Genetically modified crops or GM crops are plants that have been genetically modified by the insertion of foreign DNA molecules into traditional crop strains. Plants such as soy beans, cotton, corn, rice, sugar beets, tomatoes, and potatoes have been genetically modified over the past years (Nap et al. 2003). Most conventional farmers who use regular methods, such as spraying pesticides and using chemical fertilizers, consider planting GM crops. Because of the genetic modification, they may already be resistant to pests and diseases, as well as tolerant to herbicides and environmental extremes. As a result of this, the farmers are able to produce more crops and use less labor, thus bringing them more money.

Scientific advances in the genetic engineering and modification of crops has led to the fear that technology will harm human health and may have undesired impacts on the environment. So to access the potential ecological impact of field or commercial releases of GM crops in a given region, the likelihood and impact of cross-pollination into the natural environment in a region should be taken into consideration.

Within the last fifteen years there has been no proof that GMO crops are harmful to human health (Bren, 2003). Another concern of GMO crops is the environmental impact that they may cause. GM crops have shown to limit farmer’s seed diversity choice, cause unexpected environmental problems and may affect the future of organic farming industry.

Organic Farming vs. Conventional Farming
Organic farmers and people who buy fresh produce would rather not consider GM crops. Organic farming is a method of farming in which the crop is grown without the use of chemical fertilizers, pesticides, or genetically modified organisms (GMO) (Lohr, 2001). Organic farmers use other natural products such as planting other crops that the insects would like such as
raspberries to protect tomatoes (Glaser Organic Farm Miami, FL). In addition organic farmers also use natural seaweed as a fertilizer (Glaser Organic Farm Miami, FL). Chemically synthesized fertilizers contain phosphate and nitrogen which is used to help the crops grow faster than organically grown crops. The difference between organic and conventional food is how the food has been produced and processed. For instance, conventional framers use fertilizers, pesticides, and sometimes GMO whereas organic farmers do not use any of these. Organic farming systems rely on crop rotation, animal and plant manures, some weeding by hand and biological pest control.

**Problem Statement**

Our research group, The Food Processors, was set up to investigate the impact of genetic technology on our everyday lives. According to literature, a significant amount of soy and corn crops have been genetically modified. Food made from these crops have already been released to the market and approved by the FDA. Any food that contains GM crops doesn’t have to be labeled as GMO food. So our group wanted to find out which foods purchased from stores contain GM crops. We also wanted to find out if GM crops have contaminated the organic food market through cross pollination.

**Hypotheses**

1. Soy and corn food products purchased at conventional grocery stores such as Publix contain GMO.

2. Organic food from Whole Foods market does not contain GMO.

**Materials and Methods**

We bought several food samples and tested them for genetic modification (GM). The table below is a list of the food samples we tested from Whole Foods Market and Publix, a conventional grocery store.

<table>
<thead>
<tr>
<th>Name of Food</th>
<th>Organic</th>
<th>Conventional</th>
<th>What Grocery Store item is bought from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peas</td>
<td>Yes</td>
<td>No</td>
<td>Whole Foods Market</td>
</tr>
<tr>
<td>Soy Crisps</td>
<td>Yes</td>
<td>No</td>
<td>Whole Foods Market</td>
</tr>
<tr>
<td>Mung Beans</td>
<td>Yes</td>
<td>No</td>
<td>Whole Foods Market</td>
</tr>
<tr>
<td>Soy Nuts</td>
<td>Yes</td>
<td>No</td>
<td>Whole Foods Market</td>
</tr>
<tr>
<td>Veggie Burger (Patty)</td>
<td>No</td>
<td>Yes</td>
<td>Whole Foods Market</td>
</tr>
<tr>
<td>Cheetos Puffs</td>
<td>No</td>
<td>Yes</td>
<td>Publix</td>
</tr>
<tr>
<td>Pork Tamale</td>
<td>No</td>
<td>Yes</td>
<td>Publix</td>
</tr>
<tr>
<td>Frozen Sausage Patty</td>
<td>No</td>
<td>Yes</td>
<td>Publix</td>
</tr>
<tr>
<td>Negative Control (Bio-Rad certified GMO Free Oats)</td>
<td>Yes</td>
<td>No</td>
<td>Laboratory N/A</td>
</tr>
<tr>
<td>Positive Control DNA</td>
<td>No</td>
<td>Yes</td>
<td>Laboratory</td>
</tr>
</tbody>
</table>
**DNA Extraction**

We ground our food samples with a mortar and pestle. Then we pipetted 10 ml of H₂O into the mortar. We ground the sample into a slurry mixture. Then we pipetted 1 ml of the slurry mixture of our samples into an already labeled test tube. We pipetted 50 µl of the slurry mixture into another test tube and added 500 µl of Instagene, which is a DNA extraction buffer containing small beads, to the new test tube. We vortexed the test tube with Instagene for approximately 30 seconds. Then we placed the test tube in 95°C of hot water to denature the cells for 10 minutes. After that, we put the test tubes in ice and then into the freezer overnight, or until the next time we worked on it. We centrifuged the sample at 13,000 rpm for ten minutes to separate the cell contents from the DNA.

**PCR**

Polymerase Chain Reaction (PCR) generates billions of copies of DNA for a part of the DNA you want to study. We labeled 2 PCR tubes – one for chloroplast primer and the other for the GMO primer. We pipetted 10 µl of the DNA sample into a PCR tube. Then we prepared 2 master mixes, one that has primers for a chloroplast gene and the other with primers for the virus vector that genetically modifies the crop. Afterwards, we transferred 10 µl of master mix into the PCR tubes with the DNA samples. We put the samples into the PCR machine or thermocycler. The cycle was the following: 94°C for 2 minutes, 1 cycle, then 40 cycles of 94°C for 1 minute, 59°C for 1 minute, and 72°C for 2 minutes, followed by 72°C for 10 minutes. Samples were kept at a 4°C hold.

**Gel Electrophoresis**

We weighed the agarose powder so that it weighed approximately 1 gram. Then we poured the TAE Buffer into a graduated cylinder to 100 ml. After that, we poured the TAE buffer from the graduated cylinder into the beaker that the agarose was in making a 1% agarose gel. We microwaved the beaker until all lumps were gone and the agarose was melted. We let the liquid cool, then added 1 µl of Gel Red DNA stain into the beaker. We poured liquid from the beaker into the gel box, inserted the gel combs, and waited until the liquid became a gel. After the liquid became a gel, we took out the combs that formed wells for the DNA samples. We filled the gel box with TAE buffer. We pipetted 5µl of orange loading dye into each sample. The orange loading dye is to make the samples heavier to show where the DNA is. Then we pipetted 15µl of the samples into the wells. We plugged the gel box into the power pack and we made sure that we plugged them into the right charge (positive or negative), because the DNA samples
will run from negative to positive. Afterwards we ran the gel box at 60 volts (v) for over an hour. Then we waited until the samples in the wells were separated. We took out the gel and put it under the UV light. We used a Bio-Rad gel documentation system and computer to retrieve the results and printed out the gel picture to examine it.

Results

We tested both organic and conventional food samples to find out if they had been genetically modified. Our first PCR reaction was with organic food samples (see figure 1). The organic peas (lanes 3 through 6) showed bands for the chloroplast gene and a possible band for GMO. This indicates possible genetic modification, but remains inconclusive. For the organic Mung beans (lanes 8 and 9) there was no chloroplast band, but there was a band for GMO. For the organic soy nuts (lanes 10, 11) there was no chloroplast band, but there was a GMO band. For both brands of soy crisps, (6, 7 and 14, 15) and the veggie burger, (lanes 16, 17) there were no results. There was no band for the chloroplast for the negative control (lanes 18, 19) and as expected, there was no band for GMO. The positive control worked (lanes 20 and 21).

Our second PCR reaction was with conventional food products (see figure 2). The Cheetos (lanes 2 and 3 and lanes 6 -9) had no chloroplast bands, but contained a GMO band. There is an indication of GMO, but perhaps the food is too processed to extract chloroplast DNA. The frozen sausage patty (lanes 4 and 5) was positive for both GMO and chloroplast DNA indicating GMO in this product. The pork tamale (lanes 10 and 11) didn’t contain any chloroplast bands, but contained GMO. The other pork tamale (lanes 14 and 15) however did contain both chloroplast and GMO bands indicating this product has been genetically modified. There were no results for the sausage patty (lanes 16 and 17) but the other sausage patty (lanes 18 and 19) did not contain any chloroplast bands but did contain GMO. The positive control worked (lanes 12 and 24) but, the chloroplast DNA in the negative control didn’t amplify.

Our third PCR consisted of the same food samples as our first PCR (see figure 3) – we repeated the organic food samples because the first time the negative control did not work. The soybeans (lanes 2 and3) had chloroplast but didn’t contain any traces of GMO. The soy crisps, soy nuts, the veggie burger and the second soybeans did not have any results (lanes 4, 5 8, 9, 10, 11, 16, and 17) The Mung beans (lanes 6 and 7) contained a chloroplast band, but didn’t contain any GMO. The organic peas (lanes 14 and 15) contained chloroplast bands, but no GMO bands. The negative control (lanes 18 and 19) contained chloroplast but no GMO. The positive control worked. None of these products tested positive for genetic modification.
Figure 1: Gel Electrophoresis showing results of PCR with organic food samples. Organic pea samples are circled. (Green is chloroplast and Red is GMO)

Figure 2: Gel Electrophoresis showing results of PCR with conventional food samples. The sausage patty sample (lanes 4, 5) and the pork tamale sample (lanes 14, 15) have been circled.
Discussion

Our problem statement was, which foods purchased, contain GMO genes inside of its DNA? Our hypotheses were that the organic food from Whole Foods does not have GMO, and the conventional food from Publix has GMO. The hypotheses were supported by the data from our results from the gel electrophoresis. When both the chloroplast DNA band and the GMO DNA band are shown in the gel picture clearly, then we can confirm that the food item contains GMO. Some of our samples were inconclusive because the chloroplast DNA band did not show in the gel picture, which indicated that the PCR reaction was unsuccessful. The presence of chloroplast DNA suggested the successful run of the PCR reaction, and the presence of the GMO DNA band indicated the presence of the genetically modified DNA element in the food DNA. This is because the GMO primer used in our study only selectively amplified a segment of the viral vector used in genetic modification of crop DNA. In our study, we determined that the pork tamale and the frozen beef sausage patty contain GMO. If only the chloroplast DNA band is shown and the GMO DNA band did not come out, then we can conclude that the food item may
not have GMO. In our study, we determined that the organic peas (Columbia River brand),
organic soy beans (Edamame) and organic Mung beans do not contain genetic modified element.
This is what our results for the organic food items came out to be. However if only the GMO
DNA band is shown and the chloroplast DNA band is not, then the results would be
inconclusive. In this case, either the PCR was not successful or the DNA sample has become
contaminated.

From our study, we did not identify any GMO elements in organic food, we did however,
identify GMO elements in the conventional food. Clearly, genetic technology has modified our
conventional food, your pork tamale and beef sausage patty, contain corn and soy which have
both been genetically modified. Strictly speaking, the pork tamale and beef sausage you eat
today are not exactly the same as the tamale and beef sausage your parents or grandparents used
to eat. The other result coming out of our study is that we did not detect the presence of GMO
elements in any one of the organic food items, which indicates no impact of GMO technology in
the organic food industry. At least in our study, we are confident that the organic food is the real
organic food, and they do not contain genetically modified elements.

We also encountered some problems in our experiment. Some of them are that when we
grinded, we would lose some of our samples because they would overflow, especially with the
harder to grind food items. We also would have to grind the food items more thoroughly to
obtain more DNA from the food item. We would also have to run the DNA sample longer in the
gel, because sometimes both the chloroplast DNA band and the GMO DNA band do not separate
well. Running the gel longer would increase the chance that both would be more visible.
Another problem was that sometimes a primer dimer would occur. A primer dimer is when the
primers aneal to themselves and appear as a band in the bottom of the gel. The purity of the DNA
sample will affect whether or not the PCR will work. If the sample is cloudy, then the PCR will
not work. Doing this experiment, we feel more comfortable in pippeting and carrying out a
genetics experiment and now feel as if we are truly scientists, at the age of 12.

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References

