

Did You Know... You May Be Eating a GMO?

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Project Summary

This project was designed to test different food samples to determine if the food sample was a genetically modified organism (GMO). The DNA from eight food items were extracted and polymerase chain reaction (PCR) was performed to test for the presence of the GMO sequence. By using agarose gel electrophoresis, the DNA molecules can be separated by charge and size.

A non-GMO food control DNA was used to determine if the food samples were non-GMO and a GMO positive food control was used to determine whether the food sample was in fact a genetically modified organism.

Objectives

Arguments arose between different groups of scientists about GMOs. Some believe that there are harmful consequences of GMOs such as super-weeds, super-bugs or allergic reactions and antibiotic resistances that could arise from the selectable markers used to develop the crops. Others believe that GMOs are actually better for the environment because fewer toxic chemicals and reducing stresses on the land will allow crops to be grown on previously unfarmable land. In order to determine these theories, research can be carried out in ways such as testing grocery store food products for the presence of genetically modified organisms.

Background and Rationale

Genetically modified organisms (GMOs) began in crops, in the United States, in 1996. Since then, scientists have debated the use of Genetically Modified (GM) crops in the United States because of the environmental issues as well as health concerns. GM foods are plants that have been genetically modified by the insertion of foreign genetic material. This foreign genetic material could have possibly come from a plant, not to mention of another species such as animal, fungal, or bacterial. For example, some GM crops have a gene from the soil bacterium *Bacillus thuringiensis* (Bt) inserted in the genomes. When farmers plant Bt crops, pesticide is not necessary, because the plants produce the toxic proteins inside their cells. So when pest feed on GM plants, they die. Also, in this foreign genetic material sits a code for a protein that gives the plant an advantage over crops of the same similarity. The proven advantages GM crops have over plants of its same similarity include the following: pest resistance, herbicide tolerance, delayed fruit ripening, and an increase in nutrient content. Many GM crops are thought to be better for the environment. This is because fewer toxic chemicals are put in the environment. To every advantage, disadvantages follow. Many object to GM plants because it is believed there is a chance of creating super-weeds through cross-pollination with herbicide-resistant and pest-resistant crops. Concerns have arose about allergic reactions to the proteins or antibiotic resistance springing from the materials used to develop the crops. No matter which side one takes in the GMO debate, researching and carrying out experiments are beneficial in helping make that decision.

Materials and Supplies

Note: For all lessons, the *GMO Investigator Kit by Bio-Rad[®]* was purchased. All lessons are designed for 8 groups of 4. The kit provided has enough material for a class of 32.

The following is a list of supplies that need to be gathered in addition to the kit.

LESSON 1 Extraction of DNA From Food Sample

- Beakers for distilled H₂O (8)
- Water Bath set to 95-100°C
- Mortar and Pestle (1 per workstation)
- Test Foods (Refer to Chart 1 for suggestions for food use)
- Marking Pen (1 per group)
- Microcentrifuge or mini centrifuges
- Balance and weigh boats

LESSON 2 Set Up the PCR Reactions

- 2-20 µl adjustable-volume micropipets or 20 µl fixed-volume micropipets (8)
- 2-20 µl pipet tips, aerosol barrier (8 racks)
- Beakers with ice or ice baths (8)
- Marking pens (8)

LESSON 3 Electrophoresis of PCR Products

- 20-200 µl adjustable-volume micropipet (1)
- 20-200 µl pipet tips, aerosol barrier or regular
- 2-20 µl adjustable-volume micropipets or fixed-volume 20 µl micropipets (8)
- 2-20 µl pipet tips, aerosol barrier or regular
- Power Supply
- Fast Blast DNA stain (1 bottle)
- 500 ml flask or bottle to store dilute Fast Blast Stain (1)
- Distilled Water (3.5 L)
- Gel Staining Trays (1-8)
- Agarose gel and Electrophoresis Chamber

Methods

DNA was extracted from the following eight food samples: tomato, fresh corn, papaya, squash, cut corn, cornbread mix, veggie burger, and soy beans. After extracting DNA the samples were then prepared for polymerase chain reaction (PCR). The samples were then loaded into an agarose gel electrophoresis chamber. The results were compared to a known GMO positive control and a non-GMO control.

Scientific/Technical Concepts Illustrated

Polymerase chain reaction (PCR) has three steps, denaturing, annealing, and elongation. During the denaturing step, the DNA template is heated to 94°C to separate (or denature) the double-stranded DNA. The DNA is then cooled to 59°C to allow the primers to locate and bind (anneal) to the DNA. The final step is to increase the temperature of the PCR reaction to 72°C, which is the optimal temperature for the DNA polymerase to function. In this step the DNA polymerase adds nucleotides (A, T, G, or a C) one at a time at the 3' end of the primer to create a copy of the original DNA template. These three steps form one cycle of PCR. A complete PCR amplification undergoes multiple cycle of PCR, in this case forty cycles.

Pitfall and Alternatives

Two elements of this project presented problems and/or inaccurate results.

1. Experiments #101 and #102- The DNA extraction of the tomato sample was amplified on both the non-GMO food control as well as the GMO-positive food control. It is believed that the experiment was altered due to inconsistencies in the DNA extraction of this sample
2. For each experiment, incorrect results were obtained for the non-GMO food control. The degradation of DNA is believed to cause this result. A possible solution may be extracting the DNA through another proven method.

Learning Outcomes

This experiment is useful for the learner because it gives one a better understanding of the processes which separate DNA and a familiarity with equipment used in analysis of DNA. In addition, it serves as a catalyst for discussions on consumer science and the environmental aspect of modified and innovative science technologies.

Sample Foods

Very Reliable	Reliable	Less Reliable	Very Difficult
Fresh Corn	Tortilla Chips	Veggie Burgers	Oil
Fresh Papaya	Puffed Corn Snacks	Fried Corn Snacks	Salad Dressing
Corn bread/cake Mix	Meatballs and Burgers Containing Soy	Popcorn	Cereal
Soy Flour	Soy-based protein drinks	Fries	Wheat Flour

Chart 1

Results

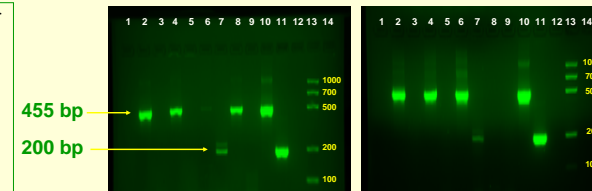


Fig. 1

Fig. 2

Sample #	Food Sample	GMO-positive	Non-GMO
2,3	Tomato		X
4,5	Fresh Corn		X
6,7	Veggie Burger	X	
8,9	Papaya		X

Sample #	Food Sample	GMO-positive	Non-GMO
2,3	Squash		X
4,5	Cut Corn		X
6,7	Cornbread Mix	X	
8,9	Soybeans		X

Experiment #101- Three samples were tested-tomato, corn, and papaya. It was determined that corn and papaya were non-GMO. The tomato sample proved inconclusive. A non-GMO food control was conducted but also showed inconclusive results.

Experiment #102- Exp. #101 was repeated with the three samples. The results were the same-corn and papaya were non-GMO and the tomato was once again inconclusive.

Experiment #103- A non-GMO control was ran along with DNA extracted from a tomato. The sample was amplified at 455 bp. From this, it was determined to be a non-GMO food sample.

Experiment #104- Four food samples were ran (see Fig. 1) it was concluded that the veggie burger was GMO-positive.

Experiment #105- Four food samples were ran (see Fig.2) it was concluded that the cornbread mix was GMO-positive.

Related Literature/Web Resources

- 1 www.Explorer.bio-rad.com
- 2 <http://pewagbiotech.org/resources/factsheets/display.php3?FactsheetID=2>
- 3 <http://gmofoodforthought.com>
- 4 Organicconsumers.org/2006/article_389.cfm
- 5 methodbook.net/dna/restrdig.html

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