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Identification of Genetically Modified Organisms in Foodstuffs

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Abstract

In this lab we identified GMOs, through the method of PCR, in all of our food samples, in our organic samples, and in corn versus soy samples. We accepted are alternative hypothesis that there were GMOs in our food samples. We also accepted our alternative hypothesis that there were GMOs in our organic samples. We then compared GMOs in our corn versus soy samples, and rejected are null hypothesis that there were the same percentage of GMOs in corn and soy. The chi square test was performed for conventional corn and soy, and organic corn and soy. We calculated the p-value for all four samples and rejected our orginal hypothesis that there were 80% of GMOs in conventional corn, 60% of GMOs in conventional soy, and 15% of GMOs in organic corn and soy.

Introduction

Taking the advantage of the universality of the genetic code, researchers have succeeded to associate DNA sequences coming from different organisms using molecular biology techniques and to integrate foreign DNA within plants. These genetically-modified organisms (GMOs) have the ability to synthesize some additional proteins which confer new properties on them (Gachet 1998). This happens by improving the protection of agricultural crops, producing optimal yield, and increasing survival of crops in a non-optimal environment. This allows increased quantity and quality of the crop, a lower cost to produce the crop, and greater benefits to the environment. It also allows the plant crop to have more nutritional value, which helps people who survive on only one main crop to fulfill their nutritional quota. The first genetically modified food products were approved by US agencies in the 1990's and included tomatoes, soybeans, and corn. Since then, there has been controversy and debate over GMO foods, such as their effects on human health and the environment in the long run, their damage to the environment and other plants, and increase in human allergies. As a result of the controversy between GMO foods and non-GMO food, food products that are bought in the US are labeled as such. Food products are tested to confirm or deny the presence of GMOs, occasionally contamination of the food occurs or testing of the food is inaccurate and GMOs are present in foods they should not be. PCR is one strategy that is used to test for GMOs in food products, where the presence of a band indicates there are GMOs. The principle of the PCR method is to multiply specific sequences of DNA, making them detectable. This highly sensitive method offers the advantage of detecting DNA molecules which are more thermostable than proteins (Gachet 1998). The efficiency of screening, identification and confirmation strategies should be examined with respect to false-positive rates, disappearance of marker genes, increased use of specific regulator sequences and the increasing number of GM foods (Ahmed 2002). In this lab we are testing for the presence of GMOs by PCR in conventional food samples, in organic food samples, and in soy and corn food samples. Our first null hypothesis is there are no genetically modified organisms in our food. The second null hypothesis is that there are no GMOs in organic food. The third null hypothesis is that there is the same percentage of GMOs in corn and soy.

Methods

The objective of this experiment is to utilize PCR to identify genetically modified foods. First, we isolated the DNA from our food samples. We did this by weighing approximately 50-100 mg of food and transferred it to a test tube. We then added 400 µl of extraction buffer to the tube and mashed the contents of the tube with a micropestle. We then incubated the test tubes at 56°C for an hour. We took the test tubes out and added 300µl of NaCl solution. We mixed the contents of the tube for thirty seconds by vortexing it, and then centrifuged the tube for 15-30 minutes. The supernatant was removed from the tube and transferred to a fresh tube. An equal volume of 100% isopropanol was added to the new test tube, and incubated in the freezer until the next lab period. One week later during the next lab, we spinned the test tubes at 4°C for twenty minutes. The supernatant was removed from the pellet, and the pellet was washed with 1.5 ml of 70% ethanol or isopropanol. The alcohol was discarded and the pellet was allowed to dry completely. The DNA pellet was then dissolved in 300 µl of 1xTE buffer, and was placed on ice until PCR was ready. We then prepared the samples for PCR, we made sure the PCR reaction pellet was at the bottom of the tube and labeled the tube. The PCR reaction mix was prepared by adding 5 µl of food DNA template for amplification and 20 µl of primer mix to the pellet. This was mixed until the pellet was dissolved. The tubes were placed in a thermal cycler for automatic cycling. Initial denaturation at 94°C for 10 min, 50 cycles at 94°C for 1 min, 63°C for 1 min, and 72°C for 1 min, and the final extension at 72°C for 10 minutes. Once this PCR process was complete, we added 5 µl of 10x gel loading solution to each sample. We stored this on ice until we were ready for agarose gel electrophoresis. The agarose gel electrophoresis was performed by the lab assistants and a select few students. After this was performed, the bands were viewed and the data was collected.

Results

After our PCR was done we obtained the following results for the GMO found in our food samples. In all of our 24 total food samples, nine of our samples had a GMO band (table 1). This was about 38% (fig. 1). Out of our 3 organic food samples, 2 of the samples showed a GMO band (table 2), which was about 66% (fig. 2). Out of our total sample size of 24, 19 samples were corn and 5 samples were soy (table 3). From the 19 corn samples, 7 showed a GMO band, which was about 37% (fig. 3). From the 5 samples of soy, 2 showed a GMO band, which was about 40% (fig. 3). We then performed the chi squared test on conventional soy and corn data, and the organic corn and soy data.

Chi Squared Test
$X^2 = \Sigma$ ((observed – expected)^2 / expected)

Conventional Corn GMO (80% expected)

$X^2 = \Sigma ((7/17 X 17) – (.80 X 17))^2 / (.80 X 17))$
X^2 =3.20
X = 1.78
P value = 4.10834

Conventional Soy GMO (60% expected)

$X^2 = \Sigma ((1/3 X 3) – (.60 X 3))^2 / (.60 X 3))$
X^2 = .355
X = 0.595
P value = 7.87944

Organic Corn (15% expected)

$X^2 = \Sigma ((1/1 X 1) – (.15 X 1))^2 / (.15 X 1))$
X^2 =4.82
X = 2.20
P value = 1.92256

Organic Soy (15% expected)

$X^2 = \Sigma ((1/2 X 2) – (.15 X 2))^2 / (.15 X 2))$
X^2 =1.6
X = 1.26
P value = 0.45494

Discussion

The object of this lab was to utilize the method of PCR to detect GMOs in our foodstuff samples. The presence of GMOs in a sample was indicated by a band in the agar gel. We compared the number of GMOs found in conventional food samples to the number of GMOs found in organic food samples. We also compared the number of GMOs found in corn samples compared to the number of GMOs found in soy samples. We first looked at the number of GMOs found in all of our food samples. We determined that approximately 38% of all of our samples contained GMOs. Based on our first null hypothesis that there are no GMOs in our food samples, we must reject this hypothesis and accept an alternative hypothesis that there are GMOs in our food samples. We then looked only at our organic samples and found that 66% of our organic samples contained GMOs. This would cause us to reject our second null hypothesis that there are no GMOs in our organic food samples, and accept an alternative hypothesis that there are GMOs in organic food samples. One reason there were GMOs in our organic food samples could be from cross contamination from other food samples in lab, while performing the PCR reactions. Another reason could be cross contamination of crops during the processing of the corn and soy. We then compared the amount of GMOs in corn versus the amount of GMOs in soy. Though our experiment we found that there was approximately 37% of corn positive for GMOs and approximately 40% of soy positive for GMOs. This would cause us to reject our null hypothesis that there are the same percentage of GMOs in corn and soy. We would accept an alternative hypothesis that there were more GMOs in soy versus corn. One reason for our outcomes was that we used a small number of samples of non varying sources of corn and soy. This experiment would be more accurate if it was performed with a greater number of food samples of varying sources and brands.

Based on the data that we collected and the equations that we calculated for the chi square test we can reject all of the data for the theory of the expected GMOs found in conventional corn and soy and the organic corn and soy. We can reject the expected theory of the amount of GMOs found based on the p-values that we calculated. All of the p-values that we calculated were greater than 0.05, which means that the theory of the amount of expected GMOs would be wrong more than 5% of the time. So, based on this we reject the theory that GMOs are found in 80% of conventional corn and 60% of conventional soy, and 15% of organic corn and soy.

Acknowledgements

In order to complete this lab successfully, I needed the help of many people. I thank Fordham University for allowing us to use their lab and materials, such as refrigerators. I also thank Dr. Lewis and the lab assistants for taking the time to teach us about the lab and helping us set up and complete the reactions. Finally, I thank my lab group and the other students in our class for bringing in food samples and running reactions, in order for this lab to be completed successfully.

Citations

Ahmed, F. 2002. Trends in Biotechnology. Vol. 20. Issue 5. pp. 215-223

Gatchet, E. et al. 1998. Trends in food science and technology. Vol. 9. Issue 11-12. pp. 380-388.

Table 1
Number of GMO Bands in All Food Samples

Number of Food Samples	Bands
24	9

Figure 1

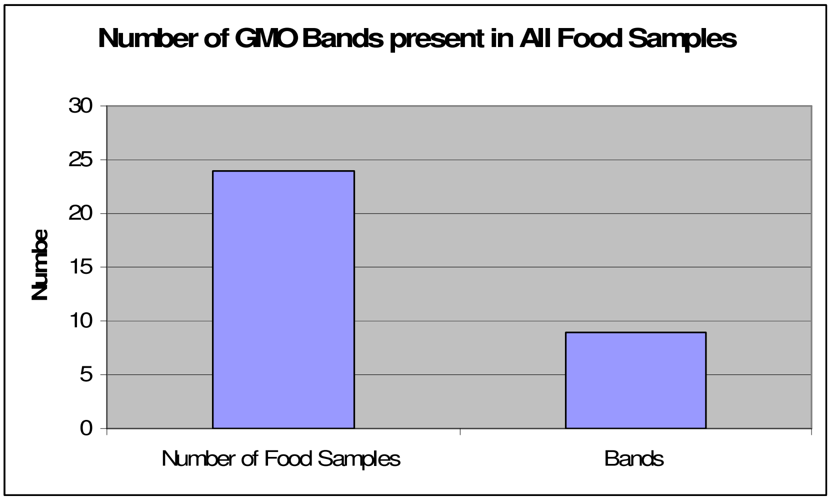


Table 2
Number of GMO Bands in Organic Food Samples

Organic Food Samples	Bands
3	2

Figure 2

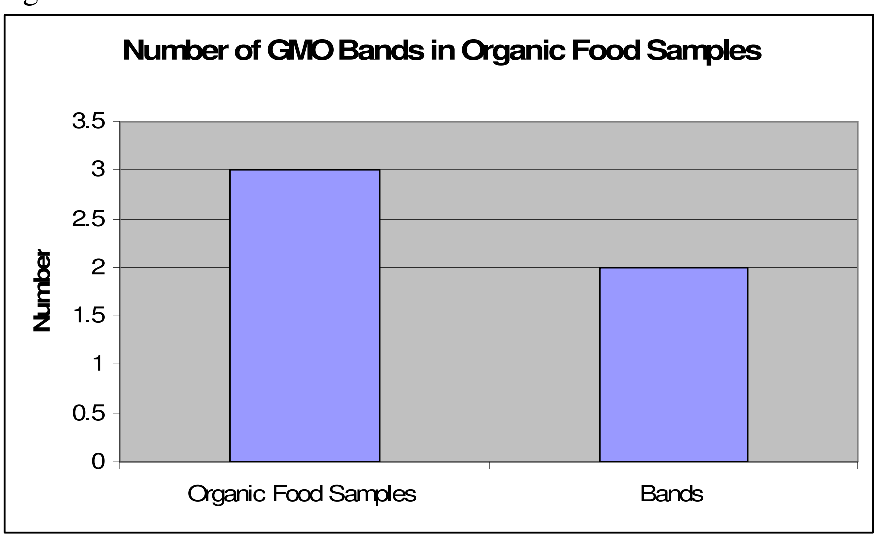
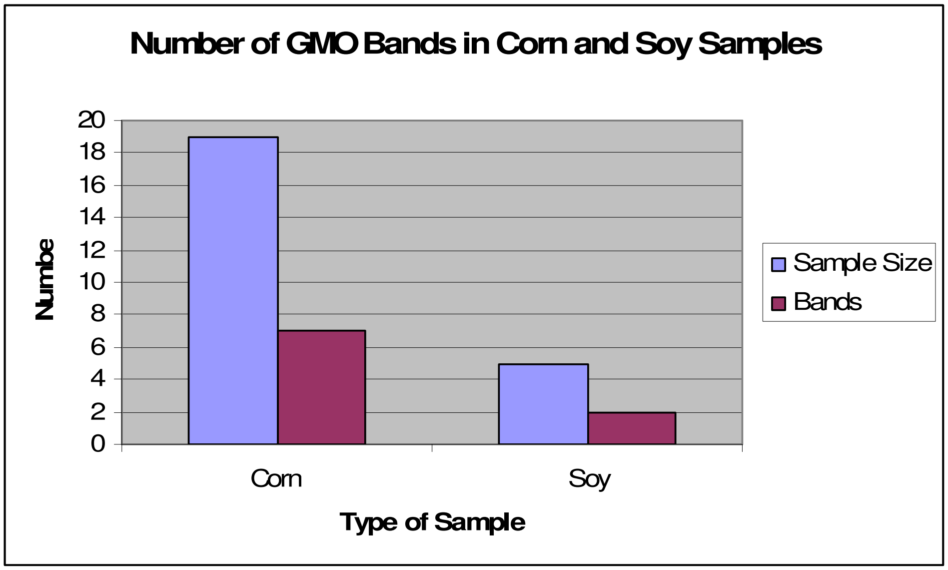


Table 3
Number of GMO Bands in Corn and Soy Samples

	Corn	Soy
Sample Size	19	5
Bands	7	2

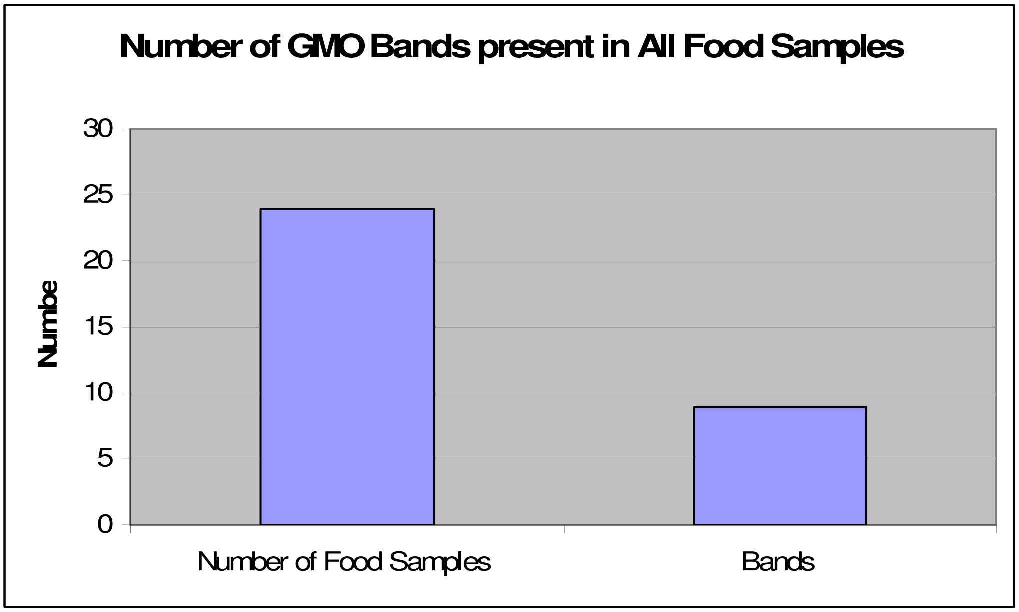
Figure 3

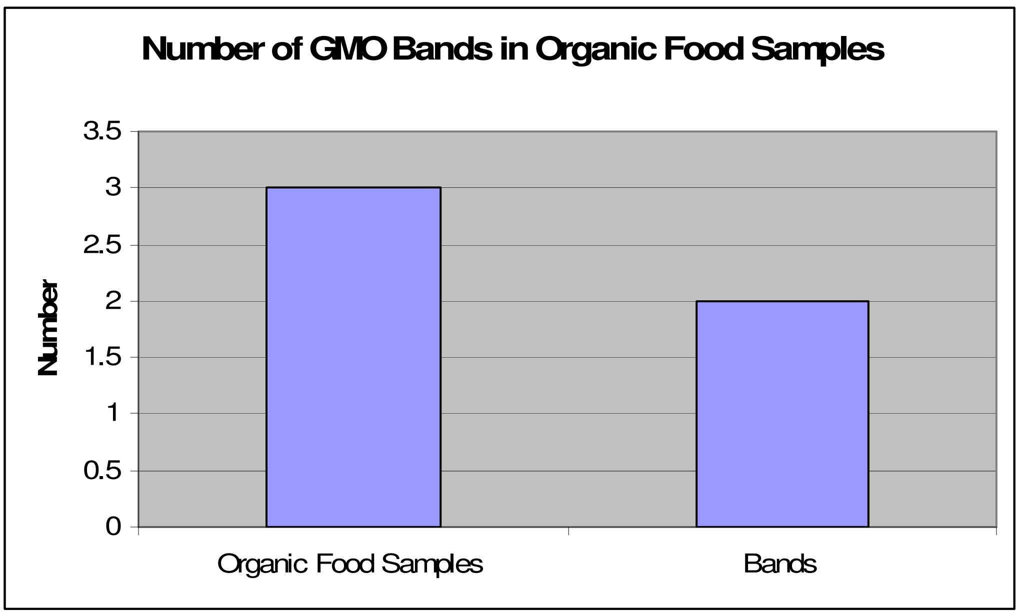


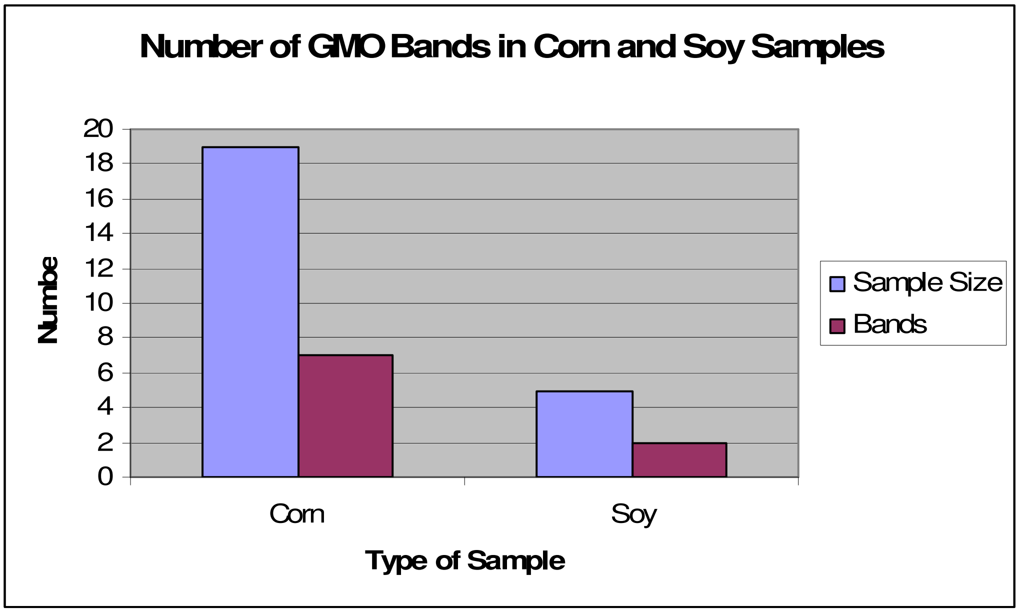
Appendix 1

Table 1

Name	Crop	Type	Band?	Brand
Kerry	corn	conventional	no	Fritos
Courtney	soy	organic	no	
Natalie	corn	conventional	yes	Fritos
Marc	corn	conventional	no	Fritos
Matt	corn	conventional	no	
Jackie C.	corn/soy	conventional	no	
Tatiana	corn	conventional	no	
Laura	soy	conventional	yes	
Jackie P.	soy	conventional	no	
Christine	corn	conventional	no	Sun Chips
Theresa	corn	conventional	no	popcorn
Ada	corn	conventional	yes	Doritos
Janine	corn	conventional	yes	Fritos
Esther	corn	conventional	yes	Doritos
Jobin	corn	conventional	no	Doritos
Austin	corn	conventional	yes	Doritos
Kurt	corn	conventional	no	Fritos
Dimitri	corn	conventional	no	Fritos
Sarah	corn	conventional	yes	
Chris	corn	conventional	no	
Vincent	corn	conventional	no	Fritos
Anamarie	soy	organic	yes	
Jeremy	corn	organic	yes	
Control			no yes	


Number of GMO Bands present in All Food Samples
30
25
20
15
10
5
0
Numbe
Number of Food Samples
Bands


Number of GMO Bands in Organic Food Samples
3.5
3
2.5
2
1.5
1
0.5
0
Number
Organic Food Samples
Bands


Number of GMO Bands in Corn and Soy Samples
Numbe
20
18
16
14
12
10
8
6
4
2
0
Corn
Soy
Type of Sample
Sample Size
Bands