An Investigation on the Correlation between Humus, Magnesium, and Yeast Growth

By Virginia Benz, Rena Collector, Kathryn Reagan, & Emily Windham

Abstract

Humus, magnesium and yeast are known to have a relationship in the natural world. Humus attracts magnesium, which in turn provides sustenance for yeast. While conducting soil tests during the ESSRE biota survey in the Roland Park Country School woodlands, it was found that one site had elevated levels of magnesium as well as high quantities of yeast. We hypothesized that high levels of magnesium in the test site were being caused by increased levels of humus which in turn caused higher quantities of yeast-life in the soil, and our group decided to test this site for magnesium yeast, and humus by collecting 24 soil samples over a period of four days. We tested each sample for yeast density, magnesium levels (ppm) and humus (0-5 ordinals). Our data neither proved nor disproved our overall hypothesis. Since a linear regression analysis of the data showed there was no relationship between humus and magnesium levels, this shows other environmental factors interfered in a known environmental relationship. Further research could be conducted on the different types of yeast and effects of the runoff from the playing fields upstream of the site on the magnesium levels.

Introduction:

Humus, magnesium, and yeast have a known relationship in nature. Decomposition of once-living matter such as fallen plant life is performed by organisms such as yeast. During this process complex molecules are broken down into the simpler organic compounds that form humus (Nardi, 2003). Humus is acidic (and therefore contains high amounts of positive hydrogen ions), and when these positive ions are lost through leaching (Nardi 2003), the humus becomes negatively charged and attracts and binds to cations (including magnesium). This binding thereby prevents these cations from being taken or lost from the soil.

However, yeast cells use magnesium to produce enzymes that allow them to perform the fermentation process (the production of carbon dioxide and ethanol that yeast uses for energy) (Alton 1999). Therefore the condition of the humus determines the availability of the magnesium for yeast and consequently their ability to live.

During the 2006 Environmental Science Summer Research Experience for Young Women (E.S.S.R.E) biota survey in the forested area of Roland Park Country School located in Baltimore, Maryland, it was found that there were both high numbers of yeast colonies and high levels of magnesium in unusual locations. Through preliminary testing of Site 4 (39.36N, 076.64W), one of three sites studied this year, the average amount of yeast in Site 4 was 3,745,454.55 yeast per cc of soil and the average amount of magnesium in Site 4 was 88.5 ppm (E.S.S.R.E Microclimate Databases, 2001). However, in the 2005 program, significantly lower amounts of both yeast and magnesium were found with 22008.33 yeasts per cc and 15.20 ppm of magnesium (E.S.S.R.E. 2006).

This discrepancy between magnesium and yeast levels from the 2005 ESSRE program to the 2006 program could be due to the fact that plant life has drastically declined during the past year in Site 4 (see photos)(E.S.S.R.E Microclimate Databases). This rapid depletion of the vegetation in Site 4 could have caused an increase in decomposition in this site. Therefore, as an explanation to the high levels of magnesium and yeast, our group hypothesized that decomposition could have caused the high levels of magnesium now found in the soil which in turn could account for the higher density of yeast now found in the soil. Using Site 3 (N 39.35797; W 076.63836) as a control due to its consistently lower levels of magnesium and yeast, we tested samples of soil from both Sites 3 and 4 for humus, magnesium, yeast in order to determine if our group's hypothesized correlation exists.


Site 4 – 2005


Site 4 - 2006

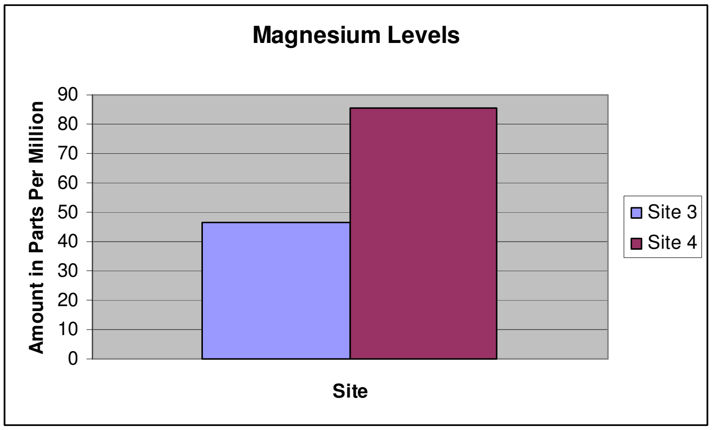
Methods:

A total of 24 samples of soil were collected from sites 3 (39.35823 N, 76.63850 W) and 4 (39.35784 N, 76.63898 W); 3 from each quadrat. 8 samples, 2 cm in diameter and 15 cm long, were taken each day with a soil corer over a period of 3 days. The soil samples were then tested for magnesium (ppm) and humus (ordinal scale 1-5) using the LaMotte Soil Testing Kit STH series. Additionally, the samples were simultaneously tested for the density of yeast in each one using serial dilution to the 10^{-3} dilution, where 100-µL aliquots from each of the 10^{0} to the 10^{-3} dilutions were plated onto separate 3M Petrifilm™ sheets. The sheets were then left to grow for three days at room temperature in a dark location. On the fourth day, we determined which dilution contained at least 5 colonies and was the most dilute for each sample. To determine the number of yeast per cm^3 in the original soil sample, the number of colonies were then multiplied by 100 (to determine the quantity in the dilution tube from which the counted sample was derived) and then multiplied by $10^{|\text{dilution factor}|}$.

Results:

To find the relationships between all of our collected data, we first graphed the magnesium levels, humus levels, and number of yeast colonies recorded at Sites 3 and 4 into bar graphs. See **figure 1**, **figure 2 and figure 3** respectively.

Figure 1



From **figure 1**, it is clear that magnesium levels have remained high at the test site, and on average, there is a 85.63 ppm increase in additional magnesium available in the soil compared to that available in the control soil.

Figure 2

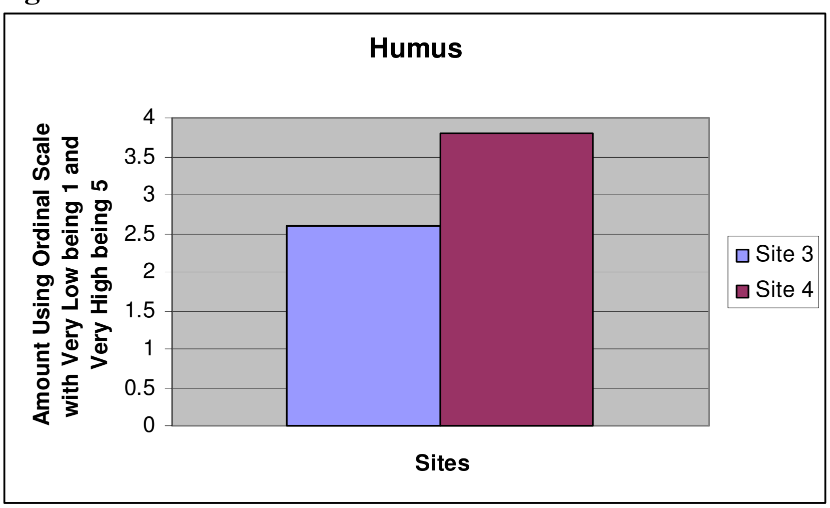
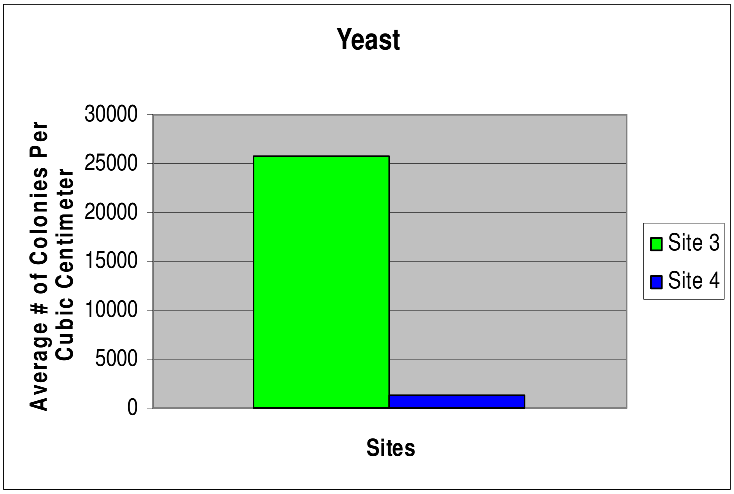


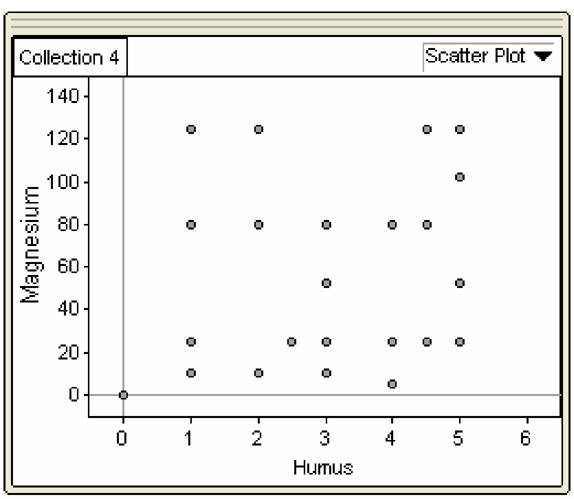
Figure 2 shows a similar result found for humus levels. In the test site, humus levels were found to be 3.8 on the LaMotte STH-14 test kit scale compared to 2.6 in the control soil. However, while site 4 saw an increase in levels of both magnesium and humus, Figure 3 shows that the quantity of yeast in Site 4 actually dropped precipitously.

Figure 3



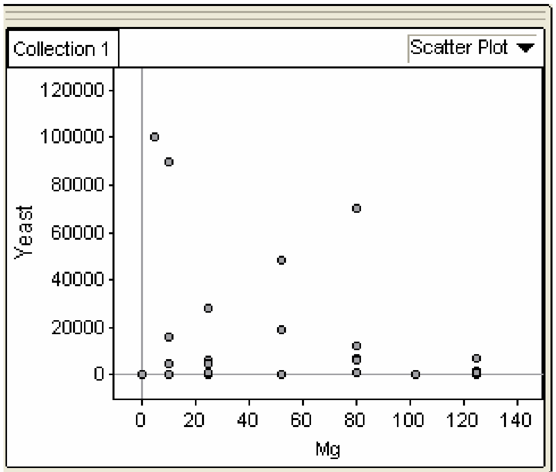
A linear regression analysis of the overall relationship between magnesium and humus (see figure 4) revealed that there was no apparent relationship between magnesium and humus (r2= 0.059864)

Figure 4



However, a linear regression analysis of the overall relationship between magnesium and yeast (see figure 5) revealed, a slight inverse relationship between the two (r^2 = 0. 10857).

Figure 5



Discussion

Before beginning our experiment we hypothesized that decomposition could have caused the high levels of magnesium now found in the soil which in turn could account for the higher density of yeast now found in the soil. However, we were neither able to prove or disprove our hypothesis.

First, the predicted relationship between magnesium and yeast failed to appear in our data. Figure 5 shows an inverse relationship between the two and the linear regression analysis confirms this (r^2= 0. 10857). Therefore, at best, our hypothesis is incorrect. However, when examining figures 1 and 2, it appears that our data confirms the relationship between magnesium and humus that we predicted, but as the linear regression analysis shows, there does not appear to be any relationship between the magnesium and humus levels of site 4. Our data implies that these two factors are independent of each other (r^2=0.059864), which is the exact opposite of the known relationship between magnesium and humus (Nardi, 2003). This implies that our data is invalid.

In addition, during our research, we found a reason to suspect that calcium was also involved (Food and Agriculture Organization of the United Nations 2006). Therefore we tested some of the final soil samples for calcium as well. We expected to find low calcium levels, due to the high magnesium levels. However, linear regression analysis of our calcium and magnesium data show there was no apparent relationship between the calcium and magnesium at site 4 either (r^2= 0.0081514), which again contradicts known environmental relationships, giving us further grounds for rejecting all of our data as invalid.

We came to conclude that some other factor must be affecting our test site. If all of our data points are independent of each other, another factor must be causing the changes we observed in humus, magnesium and yeast levels. There are numerous different factors that could be affecting our site but we believe that it could be due to the types of yeast in the soil at site 4. There are many different varieties of yeast, and not every single species could react positively to increased magnesium levels, and therefore if we were to repeat this experiment, we would identify the different species of yeast and hopefully come to more conclusive results.

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