The Effect of Chloride Levels on Mold Densities in the Soil

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Abstract

Fungi are key to a successful ecosystem. They help decompose organic matter in the soil by excreting enzymes that break apart any dead material. In the E.S.S.R.E. 2019 Biota Survey, there was a significant amount of discrepancies in the data collected, specifically with the relationship between chloride levels and mold densities. We hypothesized that the chloride, a well-known drying agent, could be causing the mold which thrives in moist conditions to dry up and perish. 30 soil core samples, 15.5 cm deep and 2 cm wide, were taken from the 5 E.S.S.R.E microclimate plots over the span of two different days and were tested for chloride levels and mold density. The tests performed proved no correlation between chloride and mold. Further research proved that the numerous species of mold react differently to many factors of the environment, including chloride levels. In the future we would refine the species of mold being tested against chloride to obtain better, more accurate results.

Introduction

Fungi are heterotrophs that cannot create their own food and are therefore dependent on other organisms for their nutrients. Typically, they grow in soils as long strands or threads, known as hyphae, which force their way through particulate matter, roots, and rocks to increase the mold’s surface area and improve nutrient absorption. In some cases, hyphae may form into masses called mycelium or wide cord-like structures called rhizomorphs that entwine plant roots in symbiotic relationships (Ingham, E.). These hyphae assist the plants in obtaining nitrogen, phosphorus, micronutrients, and water in trade for sugar from the plants (Hoorman 2016). Many fungi act primarily as decomposers in the soil food web. In addition, they can also aid in nutrient cycling, water dynamics, and disease suppression and as fungi grow, their hyphae and spread out in the dirt, they bind soil particles together creating stable aggregates that improve water infiltration and soil water holding capacity, (Stockwell, M., Clulow, J., Mahony, M., 2012) enabling them to get additional nutrients from its surroundings.

Hyphae however only grow when fungi are in a moist, healthy environment. (Brock, 2019) Furthermore, the soil must have a low pH or be slightly acidic for fungi to thrive, (Hoorman 2016) and when these conditions are not present, mold takes another form called yeasts which are unicellular (Ingham, E.). A yeast is a shelled form of fungi because of the lack of moisture in its environment; it’s trying to hold onto the little moisture left in the soil. Thus, yeast are a protected form of fungi and when yeast is denser in an environment, the ecosystem is disturbed.

That being said, while reviewing our collected data from the ESSRE 2019 Biota Survey, we noticed a few significant inconsistencies in the chloride levels and mold densities in each of the ESSRE Microclimates (ESSRE, 2019). It was observed that the sites with the lowest chloride levels had the highest mold and yeast density. We believe the inconsistencies seen in Table 1 between the different locations are due to the varying levels of chloride. For example, as Table 1 shows, Microclimates 5 (N 39.21508; W 076.38393) and 3 (N 39.35797; W 076.63836) both had the lowest chloride levels, yet the highest mold densities. Microclimate 1 (N 39.35794; W 076.63977) had the second highest chloride reading and the second lowest mold density. While Microclimate 4 (N 39.35733; W 076.63840) had the highest chloride level and the lowest mold density. Mold tends to thrive in a moist environment, and the presence of chloride, a component of commonly used drying agents, decreases the necessary moisture for mold to thrive (Bacher, A. ,2005). Microclimates 4, 5, and 3 had a huge jump from 0-158 Cl yet they were all in close proximity to one another. If each microclimate is near the other, the data should be similar, but it varies, which is why we decided to investigate this further. In sum, we hypothesize if the chloride levels are low, then mold populations will be denser.

Table 1	Microclimate 1	Microclimate 2	Microclimate 3	Microclimate 4	Microclimate 5
chloride (ppm)	54	14.5	0	158	0
mold(#/cc)	16,000	22,000	65,000	6,000	45,000

Methods

5 locations in the ESSRE Microclimate Sites were chosen based on average chloride levels in Microclimates 1-4 from the 2016-2018 ESSRE Biota Survey (ESSRE, 2019): N 39.35794; W 076.63977 (274.16 ppm); N 39.35740; W 076.63893 (40.08 ppm); N 39.35797; W 076.63836 (41.58 ppm); N 39.35733; W 076.63840 (129.12 ppm); and N 39.21508; W 076.38393 (0 ppm) (ESSRE, 2019). 3 cylindrical soil samples 2 cm in diameter by 15 cm deep were taken from each location on the mornings of July 18, 2019 and July 19, 2019 for a total of 15 samples per day and 30 samples total. Samples were dried overnight before testing for chloride levels (ppm) using a LaMotte Combination Soil Outfit Kit. Simultaneously, soil mold and yeast densities at each location were determined using a serial dilution method, diluting 1cc of each soil sample with sterile water to the 10^{-2} dilution. 100 µl aliquots from each culture tube was plated on its own individual 3M Petrifilm™ Yeast and Mold Count Plate and allowed to grow for 72 hours before counting.

Results

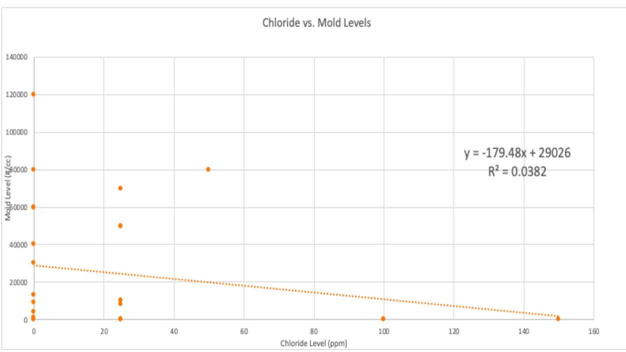

Figure 1 is a scatterplot graph showing the level of mold vs the level of chloride in the soil for each sample taken.

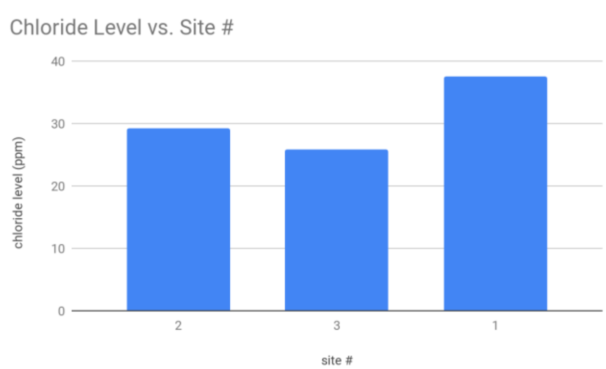

Figure 2 shows a more narrow comparison of sites 2, 3 and 1 and their chloride levels due to their reflecting the expected correlation predicted in the hypothesis.

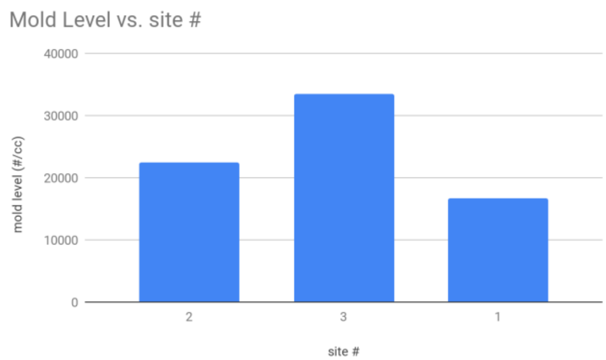

Figure 3 shows a more narrow comparison of sites 2, 3 and 1 and their mold levels due to their reflecting the expected correlation predicted in the hypothesis.

Mold and Chloride t-tests	2 v. 3	2 v.1	3 v. 1
Mold	0.7	0.35	0.18
Chloride	0.29	0.7	0.87

Table 2 is a table showing the p values for t-testing conducted on sites 2, 3, and 1 for both mold and chloride.

Discussion

Our hypothesis predicted that the mold levels in the soil were directly affected by the chloride levels and based on the results of E.S.S.R.E.'s 2019 Biota Survey, we anticipated that the higher the chloride levels, the less dense the mold would be. As Figure 1 shows, we seem to have observed the anticipated correlation between soil chloride levels and mold densities. In addition, as Figures 2 and 3 show, sites 2, 3, and 1 show the exact correlation anticipated. However, as seen in Table 2, a statistical analysis of the sites reveal that there is absolutely no correlation whatsoever between each individual site's chloride levels and mold densities ($p = 0.18$-0.87). Furthermore, the r^2 for the equation in Figure 1 is 0.0382; hence our data suggests that chloride levels are having absolutely no substantial effect on mold levels at all, disproving our hypothesis.

Our data, though, also contradicts the well documented inverse correlation between mold and chloride (Bacher, A., 2005). The high levels of chloride found, especially in Site 4, should have had a larger impact on the mold density (Figure 1). Instead, the mold density is the second highest number overall with 31683 /cc. Upon further research, we discovered this anomaly could be the result of species variation. The strong negative correlation between chloride and mold has only been documented in Saccharomyces cerevisiae. Considering that we only tested for mold densities, this could be a factor affecting our results. In addition, each species reacts differently to its environment including the pH, temperature, light, and water activity (Kung'u, J., n.d.). Therefore in the future, we would attempt to isolate different species of mold in the soil before testing how chloride affects them.

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