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Proceeding Paper

Impact of Acid Rain with Different pH Values in *Monstera deliciosa* Plants †

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Abstract: The present research experimentally outlines the reaction of a *Monstera deliciosa* plants to the effects of acid rain at various pH levels. Sulfuric acid was used to simulate acid rain, with prepared solutions having four different pH values. Paper chromatography showed that the plant's pigment begins splitting more and the chlorophyll further deteriorated. The plants also started to lose their ability to be soluble. Through spectrophotometry, plants with the lowest pH levels of acid were losing their capacity to absorb light and radiation more quickly since their absorbance values were lower.

Keywords: acid rain; *Monstera deliciosa*; sulphuric acid; pH; paper chromatography; chlorophyll; spectrophotometry

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1. Introduction

Acid rain refers to a variety of ways in which acids are released into the atmosphere. This research evaluates the consequences of acid rain on living and deceased *Monstera deliciosa* plant, simulating acid rain with sulphuric acid with different pH levels to intensify the solutions' acidity, examining how *Monsteras* react to different acidic environments. *Monstera deliciosa* plants can grow in a soil that has a pH level between 5.0 and 7.5. Although *Monsteras* can thrive in acidic soil, they do not meet the criteria for a true acid-loving plant [1]. *Monstera* plants were chosen to be tested as they can grow fast indoors; therefore, when changing their desire environment, speedy reactions will occur [2]. The analysis was carried out by performing paper chromatography and spectrophotometry. The impacts of acid rain on plants are well-studied, particularly those that flourish in aquatic habitats, are the reason why an indoor plant was chosen to be studied.

Plants with the most acidic solutions were predicted to show less resistance to sulphuric acid solutions. The plants receiving the solutions with the lowest pH levels, through paper chromatography, will show a lesser range of pigments with weaker colours, as chlorophyll is being deteriorated. Through spectrophotometry, *Monstera* plants will lose their ability to absorb radiation at different wavelengths, showing lower absorbance values. From 330 nm to 420 nm, absorbance values tend to decrease. At 430 nm, there should be an increase in the absorbance registered, since chlorophyll A absorbs the light in the blue wavelengths, with absorption peaks at 430 nm [3].

2. Procedure and Results

Five *Monstera deliciosa* plants were used for the experimental protocol. Acid rain was simulated with sulphuric acid at 98% concentration with a density of 1.92 gmL^{-1}, a strong acid, and distilled water solution. Then, 4 mL of sulphuric acid was used and a total of 1000 mL of distilled water. Sulphuric acid with distinctive pH values was made in different solutions, using four volumetric flasks (each for its respective pH), to reproduce the differences between the acidity of acid rain. pH was measured using the *Texas TI-Nspire CX II* calculator pH meter and a universal pH meter. Paper chromatography and spectrophotometry were carried out to analyse the effectiveness of acid rain, using the *Zuzi* spectrophotometer model 4111 RS and cuvettes. Each plant was assigned a specific sulphuric acid solution, the same solution with the same pH being poured during the entire experiment. One of the plants was not given water for a week before initiating the experience to represent a deceased and not well-treated plant (identified as "No treatment"). The procedure was applied three days per week—Monday, Wednesday, and Friday—for three weeks. The temperature was measured using the temperature meter of the *Texas TI-Nspire CX II* calculator, being proved not to affect the results. Then, 10 mL was poured on the plants each day, the solution being doubled at day ten since all plants kept showing some resistance.

2.1. Paper Chromatohraphy

2.1.1. First Day of Experiment

Paper chromatography was performed before applying the acid solutions as they were all under the same conditions, besides the "No treatment" plants. A leaf of each plant was taken and placed in its respective and identified mortar (one for each plant being treated with its sulphuric acid solution), where 5 mL of di-ethylether was added, crushing the leaves with the solvent using a pestle. A 6 × 8 cm chromatography paper was cut, 1 cm margin was left at the bottom for the paper to be dipped in hexane. Five drops of each preparation, which was suspended vertically in the solvent chamber only touching the levels of the solvent. Hexane was used since it is a potent non-polar solvent, due to the lack of electronegativity in the H-C bond, repelling polar components and attracting non-polar components. Figures 1 and 2 correspond to the performing of paper chromatography twice regarding the *Monstera deliciosa* plants.

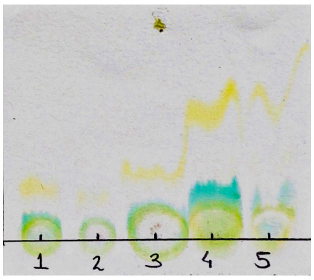

Figure 1. Chromatography 1st trial.

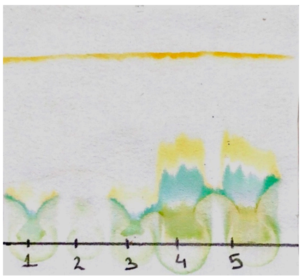

Figure 2. Chromatography 2nd trial.

2.1.2. Ninth Day of Experiment

While analysing the three chromatograms, Figures 3–5, the yellow pigment has a stronger presence, meaning the chlorophyll keeps deteriorating as the sulphuric acid mixture is applied. A larger chromatography paper was cut, 14 × 7 cm, to have a larger distance between the samples extracted from the plants.

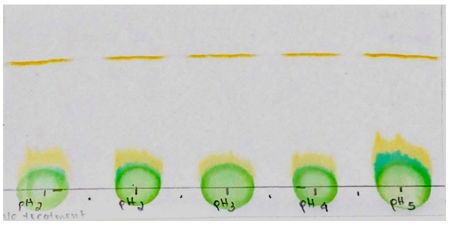

Figure 3. First trial at 9th day.

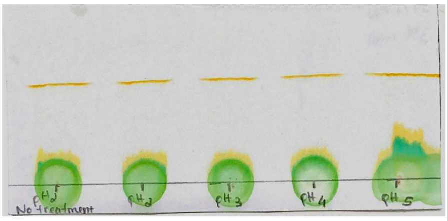

Figure 4. Second trial at 9th day.

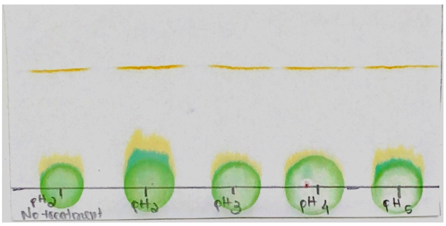

Figure 5. Third trial at 9th day.

2.1.3. Eighteenth Day of Experiment

All plants showed yellow leaves, as only yellow leaves were used this day. It may be assumed that sulphuric acid solutions caused, in all plants, almost the total deterioration of the chlorophyll pigment. This degradation caused the leaves to turn yellow.

2.2. Spectrophotometry

2.2.1. Tenth Day of Experiment

The first spectrophotometry was performed after four applications of the 10 mL acid solutions. The leaves were crushed with distilled water using a mortar and pestle, passing it, with a Pasteur pipette, into a funnel where there was filter paper to retain all the impurities, draining the clean extraction of the leaves. This extraction was placed in a cuvette and then inserted into the spectrophotometer. The values read by spectrophotometer were obtained by the wavelengths present in the blue region of the spectrum, from 330 nm to 520 nm. Analysing Figure 6 with all plants, generally the absorbance decreases from 330 nm to 420 nm. At 430 nm, there is an increase in the absorbance registered, which goes according to the literature. Contrary to chromatography, this experiment shows data that are capable for distinguishing how the different pH values of the sulphuric acid affected the plants. As shown in Figure 6, there is an increase in the absorbance values as the pH increases. Verifying the hypothesis, the lower the pH values, the more damage the sulphuric acid solution will cause to the plant. The "no treatment" plant also showed a much lower absorbance value.

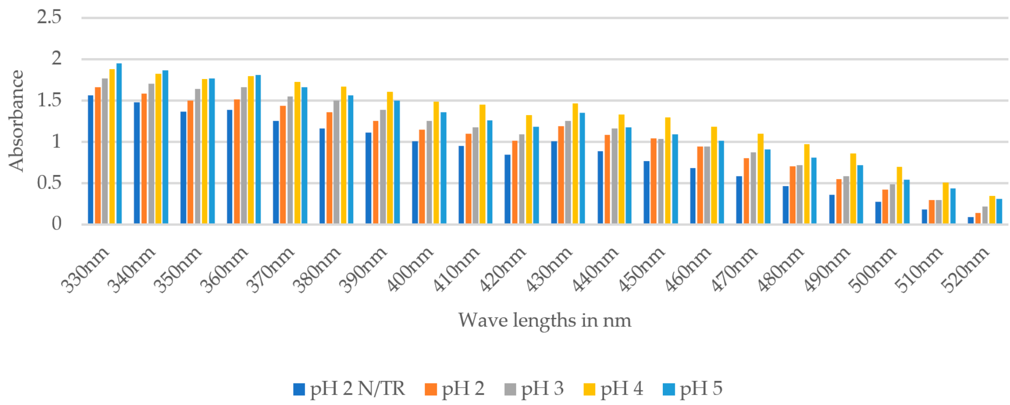

Figure 6. Spectrophotometry of *Monstera deliciosa* plants after 4 applications of the 10 mL sulphuric acid solutions.

2.2.2. Nineteenth Day of Experiment

Second spectrophotometry was performed where four times the 20 mL solution had already been applied. More accurately in Figure 7, all values have decreased in comparison to Figure 6. The doubling of the solution applied to 20 mL guided the plants to lower values of absorbance, meaning a greater loss of their capabilities of absorbing light and radiation. The plant being applied with the highest pH value showed results that were kept almost identical, with few decreases to the ones before, which proves the affirmation that these plants are more likely to grow in a soil where the pH is between 5.0 and 7.5. In the same way, there is an increase in absorbance from 420 nm to 430 nm, leading to a peak representing each plant. Also, there are negative values in all trials for the plants with pH values of 2. Physically, negative values should not be presented, as they are not possible to reach or analyse, but chemically, they signify that the amount of light that passes through the sample is more intense than the amount of light that passes through the reference.

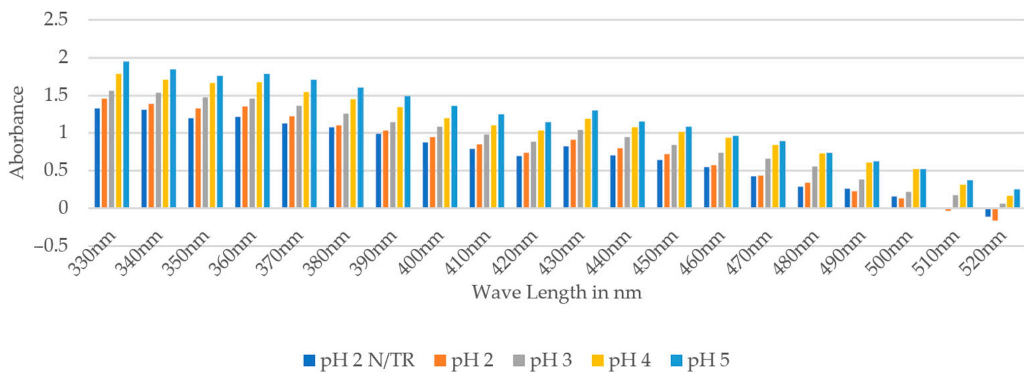

Figure 7. Spectrophotometry of *Monstera deliciosa* plants after 4 applications of the 20 mL sulphuric acid solutions.

3. Discussion and Conclusions

Via paper chromatography, because chlorophyll is degrading, plants receiving solutions with the lowest pH level solutions will exhibit a smaller variety of pigments and weaker colours.

Through spectrophotometry, by having quantitative data to investigate, plants suffering from the lowest pH sulphuric acid solution were losing their capabilities of absorbing light and radiation more quickly by showing lower absorbance values.

Therefore, by paper chromatography and spectrophotometry, this investigation has demonstrated how acid rains of various pH levels affect Monstera plants.

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Conflicts of Interest: The authors declare no conflict of interest.

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