

Extraterrestrial Life Detection via ATP & Organic Compounds Analysis

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Introduction

In determining extraterrestrial life present in soil, a Luciferin-luciferase reaction can be used to test for ATP, and results can be further supported by analyzing the organic composition of samples.

ATP is an important biosignature due to its significance in the energy transformation process for all living organisms. Early work by NASA scientists suggested ATP to be a reliable indicator of biological presence in terrestrial and extraterrestrial soil. ATP can be quantified by measuring the light produced through its reaction with luciferase using a luminometer. The amount of light produced is directly proportional to the amount of ATP present in the sample.

Since luminometers are sensitive to any light disruption, a digital camera allows for efficient and easy analysis for this task. Scientists suggest that Mars was built from the same carbonaceous material as Earth, and therefore, these elements would be available for utilization to extraterrestrial life. Additionally, compounds such, glucose, nitrogen, and phosphorus, are exclusively associated with life processes. The organic composition of soil further aids the search for life, and it can be determined via colorimetric results from a paper strip test.

Method

1 mL of DI water and 1 ml of sodium dodecyl sulfate was distributed via micropipette and was vortexed for 1 minute. The assay was inserted into the soil content and observed for 60 seconds for color change.

To create the chemical reaction for ATP, 1.0 ml of luciferin buffer solution and 2 microliters of luciferase enzyme was micro pitted into a cuvette. The cuvette was placed in a dark chamber with a digital camera and the result was analyzed under long exposure photography with a shutter speed of 15 seconds and max aperture. The solution was also tested through a photomultiplier tube to quantify the observed luminescence.

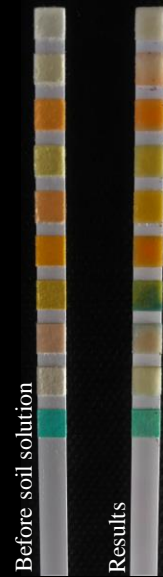


Figure 1. Paper assay

Organic Compound	Positive (+) or Negative (-) result	Trace
Glucose	+	5mmol/l
Nitrogen	+	--
Phosphorus	+	10ppm

Table 1. Results of Paper Assay



Figure 2. ATP fluorescence in soil

Results

As seen in Figure 2., a positive result for ATP fluorescence was observed; however, further trials indicated inconsistent results between samples. A positive result is observed when ATP is equal to or greater than the limit of detection which is currently being tested.

Based on colorimetric results, glucose, nitrogen, and phosphorus yielded positive results (Table 1.) The concentration of each compound was determined by the color change of the strips (Figure 1.)

Discussion

A digital camera, in essence, is a photon counting sensor. With the appropriate settings, bioluminescence can be captured and analyzed even when it is not visible to the eye. The widened aperture allows for more light emitted from samples to reach the image sensor, while a longer shutter speed exposes the image sensor to these photons for a longer time. Although the method of utilizing a camera as a photon sensor was found to be successful, it was not sensitive enough for the task. A new method is being studied on the analysis of low concentration of ATP with the use of a photomultiplier tube.

Literature Cited

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