Proceedings of the 7th World Congress on Mechanical, Chemical, and Material Engineering (MCM'21)
~~Prague, Czech Republic~~ Virtual Conference – August, 2021
Paper No. ICCPE 112
DOI: 10.11159/iccpe21.112

Silicon in *Agave Angustifolia* Haw Leaves

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Extended Abstract

The enormous agricultural waste generated from *Agave* species used for the production of mezcal in the southern Mexican state of Oaxaca, has intensified interest in finding ways to use the leaves and bagasse of these plants as sources of raw materials for other applications [1]. The objective of this work was to determine the presence of silicon in leaves of adult-*Agave angustifolia* Haw plant*s*. Plants take up silicon from soil in the form of monomeric orthosilicic acid, which is polymerized and precipitated as distinct silica (SiO_2) bodies (phytoliths), or within certain cells [2]. Silica-based nanomaterials have grown in importance for catalysis, biosensing and biomedical applications [3].

Middle part of leaves of adult-*Agave angustifolia* plants from two different regions in Oaxaca, were cut into small cubes and fixed in a solution of formalin, glacial acetic acid, ethanol (95%) and deionized water (10:5:50: 35) for 48 h. Then, washed with deionized water and dehydrated in an ethanol series. Thin slices cut out from the cubes were observed by scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM with EDX). Dehydrated samples were grinded and vibrational spectroscopy measurements were performed at room temperature by Fourier transmission infrared (FT-IR) spectroscopy. Thin slices of non-dehydrated samples were sectioned using a razor blade and stained with safranine for light microscopy observations.

The presence of elements-silicious and oxygen was initially confirmed in *Agave* leaves by sharp and strong peaks in the EDX spectra of some small areas (~ 2-5 μm). However, the EDX spectra of wider areas (~ 50 μm) in the same region showed very small signals or none of Si, indicating the specificity of the Si location. SEM images not only revealed the formation of irregular-shaped silica particles with an average width of ~ 5 μm, but also isolated zones with Si having no capability to produce Si particles. Although phytoliths in different *Agave* species (e.g*., A. americana, A. tequilana, and A. atrovirens*) have been reported as composed of calcium oxalate, the possibility of phytoliths composed of amorphous silica ($SiO_2.nH_2O$) in *Agave* has not been reported [4]. Conversely, photomicrographs showed prismatic structures at the junction between parenchyma cells in *Agave* leaf tissue, assigned to oxalate crystals according to other authors [5]. However, our SEM images were helpful in also observing oxalates crystals near the cuticle and guard cells of *Agave* leaves. The presence of the small silica particles could not be detected by the optical microscopy technique.

FTIR spectra showed typical bands assigned to cellulose, lignin, and oxalates. In addition, FTIR spectra also showed a signal at 1050 cm^{-1} in the rather broad peak at ca. 1190-865 cm^{-1} which denoted the Si-O-Si antisymmetric stretching mode (TO_3 mode) in the Agave leaves. The shoulder toward higher frequency side, that generally accompanied the TO_3 mode was also present (~1150 cm^{-1}). The inflection point located at ~804 cm^{-1} indicated the bending vibrations of (SiO_2) groups [6].

Therefore, the availability of Si in the leaves of *Agave Angustifolia* Haw was here confirmed by EDX and FTIR analysis.

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