HALOPHILIC BACTERIA STRATEGIES IN SULFATE RICH ENVIRONMENTS: PROSPECTS FOR LIFE ON EUROPA. S. I. Ramírez, R. Miranda, P. A. Figueroa, E. C. Rodríguez and L. Montoya, Centro de Investigaciones Químicas, Universidad Autónoma del Estado de Morelos. Av. Universidad #1001 Col. Chamilpa, Cuernavaca 62209 Morelos, México. Email: ramirez_sandra@uaem.mx

Introduction: The search for life beyond Earth ranks the finding of liquid water as the main factor that qualifies a habitable planet or satellite. In this sense, the discovery of geological evidences pointing to the possibility of water running on ancient Mars [1], or the emissions detected on Enceladus as evidence for the existence of internal water pockets [2], place some of the objects in the Solar System, as important targets for astrobiological studies. One of the most significant results of the Galileo orbiter mission was the discovery of geological features on the surface of Europa [3], the smallest of the four Galilean satellites that stated the basis for the existence of an aqueous layer beneath an icy water crust. These observations were supported by magnetometer studies [4]. Such evidences have raised the question of whether Europa's interior harbors an ocean favorable for life [3, 5-7].

Spectral evidence from the Near Infrared Mapping Spectrometer (NIMS) has demonstrated that some regions of Europa's surface are incompatible with pure-H_2O ice material [8]. Constrained limits on the salinity of Europa's ocean based on Galileo magnetometer measurements combined with radio Doppler data-derived interior models and laboratory conductivity *versus* concentration data range from "freshwater" (*i.e.* less than 3 g of salt per kg of H_2O) to near-saturation water (around 300 g of salt per kg of H_2O) [6].

The chemical nature of the salt proposed to exist in Europa's ocean is quite different to the most abundant salt in terrestrial oceans. While sodium chloride (NaCl) and other chlorides are common in bodies of water on Earth, the spectral evidence shows that sulfates either of magnesium or sodium ($MgSO_4$ or Na_2SO_4) are present on the deep ocean of Europa. The reason can be found after an examination of the material that formed each of these planetary bodies. If Europa was formed from materials similar to a carbonaceous chondrite then models show that the most abundant cations must be Na^+ and Mg^{2+} [7].

The organisms capable of surviving at high levels of salinity could be halotolerant or halophilic. As the average salt content on terrestrial oceans is around 3.5% NaCl, all organisms thriving at higher salt concentrations are considered halophiles. However, the stress imposed by salts different from sodium chloride are not necessary the same. One adaptive strategy to osmotic pressure used by halophilic organisms is the synthesis and/or accumulation of organic molecules of low molecular weight and high water solubility. These molecules are known as compatible solutes and help in the stabilization of some enzymes, the maintenance of cell volume and in providing protection from extreme parameters, such as high salinity, high or low temperature, or desiccation. Identified compatible solutes may be classified as amino acids, sugars or polyols, and their derivatives [9, 10].

Methodology: We characterized the compatible solutes, by ^1H and ^{13}C Nuclear Magnetic Resonance (NMR), accumulated by different halophilic bacteria when submitted to low water activities (a_w), defined by the molar concentration of NaCl or $MgSO_4$ in modified liquid cultures. Our results are discussed in the context of the habitability of Europa's ocean. The adaptive strategies used by microorganisms on Earth reveal that most of the physiological stress can be overcome as long as the environment contains liquid water [11]. According to the available information of the physical and geochemical parameters for Europa's ocean, and based on our results on the survival of the different bacterial strains at salinity concentrations within the range of the estimated salinity for the europan ocean, we can infer that this could be a suitable scenario for the presence and persistence of certain forms of terrestrial life.

References:

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