OPINION

Solar panel microbiology in Berkeley, California, USA

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ABSTRACT

A conventional surface that can be colonised by microbial community's resistant to abrasive environmental conditions, such as high irradiation, temperature variations, and desiccation, solar panels are nearly everywhere in the world. These characteristics make them not only excellent sources of stress-resistant bacteria but also common tools for researching microbial communities and the process of colonisation in various parts of the planet. Here, we present a detailed account of the microbial communities connected to solar panels in Berkeley, California, in the United States. To examine the characteristics of cultivable bacteria, including their adhesion ability, UV and desiccation resistance, we isolated them. We have also been able to learn more about the taxonomic and functional characteristics of these communities by using parallel, culture-independent metagenomics and metabolomics approaches. Using the Illumina HiSeq2500 sequencing platform, a metagenomic analysis was conducted. The results showed that the bacterial community of the Berkeley solar panels is primarily made up of Actinobacteria, Bacteroidetes, and Proteobacteria, with smaller levels of Deinococcus-Thermus and Firmicutes. Additionally, a distinct Hymenobacter sp. preponderance was seen. A functional analysis showed that all metagenomes shared genes involved in carotenoid biosynthesis and processes involved in the persistence of bacteria on solar panels (such as stress response, capsule construction, and metabolite repair). However, genes implicated in general autotrophic subsystems and photosynthetic pathways were uncommon, indicating that these systems are not essential for survival on solar panels. Liquid chromatography tandem mass spectrometry was used to perform the metabolomics. Polar metabolite composition was found to be quite comparable across the solar panels from Berkeley and Valencia (Spain); however, some metabolites seemed to be differentially represented (for example, trigonelline, pantolactone, and 5-valerolactone were more abundant in the samples from Valencia than in the ones from Berkeley). Additionally, triglyceride metabolites were present in significant concentrations in all of the solar panel samples, and the profiles at the two sites were comparable. The striking similarities between the taxonomic profiles of the solar panels from California and those that had previously been described from Spain highlighted the importance of both selective pressures and the prevalence of microbial populations in the colonisation and establishment of microbial communities..

Key Words: *Metabolomics; Solar Panels; Proteobacteria; Actinobacteria; Bacteroidetes; Chromatography*

INTRODUCTION

There may be up to one trillion distinct species on Earth, the most majority of which are microbes, according to a recent estimate. Microorganisms are everywhere and can even be found in harsh settings like marine trenches, thermal springs, and man-made structures. It's interesting to note that solar panels have been found to support a diverse microbial community, primarily made up of organisms that have evolved to withstand desiccation and radiation (much like those found in other highly irradiated environments like deserts, plant surfaces, and polar microbial mats). After 18 months, it has been demonstrated that solar panels from Brazil with biofilms on their surface had an 11% lower efficiency. Additionally, a loss of up to 0.1% of the daily power production from California's photovoltaic panels has been attributed to dust particle collection during drought seasons. The coating and angle of outdoor glass surfaces, such as photovoltaic panels, affect the deposition of biofilm and dust, among other things. Although the impact of biofilms on solar panel soiling has not been studied, it appears logical to assume that biofilm development could make dust stickier. Although there are financial advantages to comprehending the link between the biofilms that build on solar panels and their decreased yield, little is understood about how the latitude, climate, and physical properties of the panels affect.

These inert, non-porous, dimensional artificial surfaces, which are a proxy for sun-exposed natural environments like rocks, the phyllo sphere, or the top layer of biological soil crusts, make solar panels a particularly interesting environment due to their simple yet standard

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structure and orientation, their abundance worldwide, and their interest. Despite being so far apart geographically, the microbiomes of solar panels from the North and South Poles were compared in a recent study, which found that they are quite comparable. Additionally, it is possible to isolate intriguing bacteria that are resistant to radiation and desiccation from the surfaces of solar panels. According to a study, biofilms growing on surfaces exposed to sunlight have a built-in resistance to Chernobyl radiation levels because of their natural adaptability to the environment. It has been suggested that the ability of bacteria that are resistant to desiccation and ionising radiation to shield their proteins from the oxidative damage caused by exposure to radiation results in functional repair systems that function more effectively during recovery than those in bacteria that are sensitive to radiation.

A previous analysis of the microorganisms living on solar panels in Valencia, Spain-a Mediterranean city-found the presence of black fungi, a few phototrophs, and a startling variety of sun-adapted bacterial taxa, with Hymenobacter spp., Sphingomonas spp., and Deinococcus spp. as the dominant species. We present here a thorough analysis of the microbial communities on solar panels in Berkeley, California, a coastal city far from Valencia, in order to shed light on the ecology of the solar panel microbiome and to further compare the microbial profiles on panels from distant geographic locations. Both cities experience a long, dry summer, a high degree of relative humidity, and a Mediterranean climate.