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A Stellar Oasis: K-Dwarfs are at least as viable for Photosynthesis as our Sun; Results from garden cress and cyanobacterium experiments

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Light is the fundamental energy source for photosynthesis, enabling the synthesis of organic compounds. Over billions of years, photosynthetic organisms have profoundly transformed our planet into a diverse global ecosystem (1,2). Therefore, understanding an (exo)planet in the context of its stellar environment is an essential step in assessing its habitability. K-dwarf stars have gained a lot of attention in recent years as potentially offering the most bening stellar environment for putative life (3).

Here we present our results in which we investigate the viability of simulated K-dwarf radiation for phototrophic organisms. We used an LED solar simulator with a variable spectrum module which we adapted to emit radiation corresponding to a globally distributed light which would be received at the surface of a hypothetical planet in the habitable zone of a 4300 Kelvin K-dwarf star at a distance of ~0.44 AU. The resulting K-dwarf spectrum is shifted towards longer wavelengths and exhibits three times smaller fluxes overall. We exposed garden cress *Lepidium sativum* as well as the cyanobacterial strain *Chroococcidiopsis* sp. 029 to K-dwarf radiation for up to 14 days, and compared these responses to an exposure to solar radiation as well as completely dark conditions.

In summary, we find that despite a decreased red to far-red ratio (due to the relative shift of the K-dwarf spectrum towards longer wavelengths) and receiving only a third of the photons suitable for oxygenic photosynthesis (in the radiation range of 400 –700 nm), garden cress under K-dwarf radiation exhibits comparable visual growth, photosynthetic activity as well as water intake and dry mass accumulation as garden cress under solar conditions. Moreover, the cyanobacterium demonstrated a significantly more positive response to K-dwarf radiation, exhibiting both higher photosynthetic activities and culture growth. Neither organism exhibited photosynthetic activity without radiation, underscoring the significance of light for their survival.

References

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