The Effectiveness of Sunscreens in Protection from Damaging Effects of UV Radiation

Abstract

Ultraviolet (UV) radiation poses a significant threat to human health, causing skin aging and wrinkling, and, ultimately, cancer. As a result, people are encouraged to protect their skin by wearing a UV-blocking sunscreen.

Sunscreens contain varying levels of sun protection factors (SPF) and are marketed towards different consumer groups based on the sunscreen protection level.

Here we assess the effectiveness of sunscreens with higher SPF values to protect Escherichia coli (E. coli) K12 bacteria from UV radiation. We find no evidence of increased protection as SPF values increase.

Introduction

UV radiation from the sun is considered harmful to human health. Approximately 95% of the solar radiation reaching the Earth's surface is ultraviolet A (UVA) light. Ultraviolet B (UVB) rays make up about 5% but are potentially even more harmful. Short-term exposure to the latter can cause sunburn, while many other skin problems like premature skin aging or wrinkle formation are often triggered by sun damage. At significant exposure levels, UVB radiation may even cause cancer.

UV radiation, in the form of UVB rays, which have a wavelength between 280 and 315 nanometers (nm), causes cellular DNA damage by producing lesions known as cyclobutane pyrimidine dimers (CPD). The majority of DNA damage induced by UV light is reversed by the nucleotide excision repair (NER) pathway. Dimers that escape the DNA repair process, however, may cause programmed cell death (apoptosis) of affected cells in the skin, while accumulated mutations associated with the development of cancer often result from DNA replication errors.

Medical organizations recommend that humans protect themselves against the sun's radiation by applying sunscreen which blocks direct DNA damage by blocking harmful UVB rays. Knowing that an SPF (sun protection factor) rating measures how much UVB radiation is blocked, we sought to determine the effectiveness of SPF in blocking UVB radiation by irradiating E. coli K-12 with UV light in the presence or absence of sunscreen. We hypothesized that the greater the SPF protection in sunscreens and lotions, the higher the E. coli growth would be.

Results

To test our hypothesis that higher SPF levels would result in increased protection of E. coli K-12, we evenly spread 100□l from an overnight culture onto fresh tryptic soy agar (TSA) plates. The plates were divided in half and covered in Saran Wrap. One half of the Saran Wrap was shielded from radiation with foil as a negative control. The other half of the Saran Wrap was either left untreated or treated with equal volumes of lotion SPF-0,

sunscreen SPF-4 or sunscreen SPF-50, in triplicate, and irradiated for 90 seconds at a distance of 13.5 cm from a UV-light source (model XX-15M), with a wavelength of 302 nm.

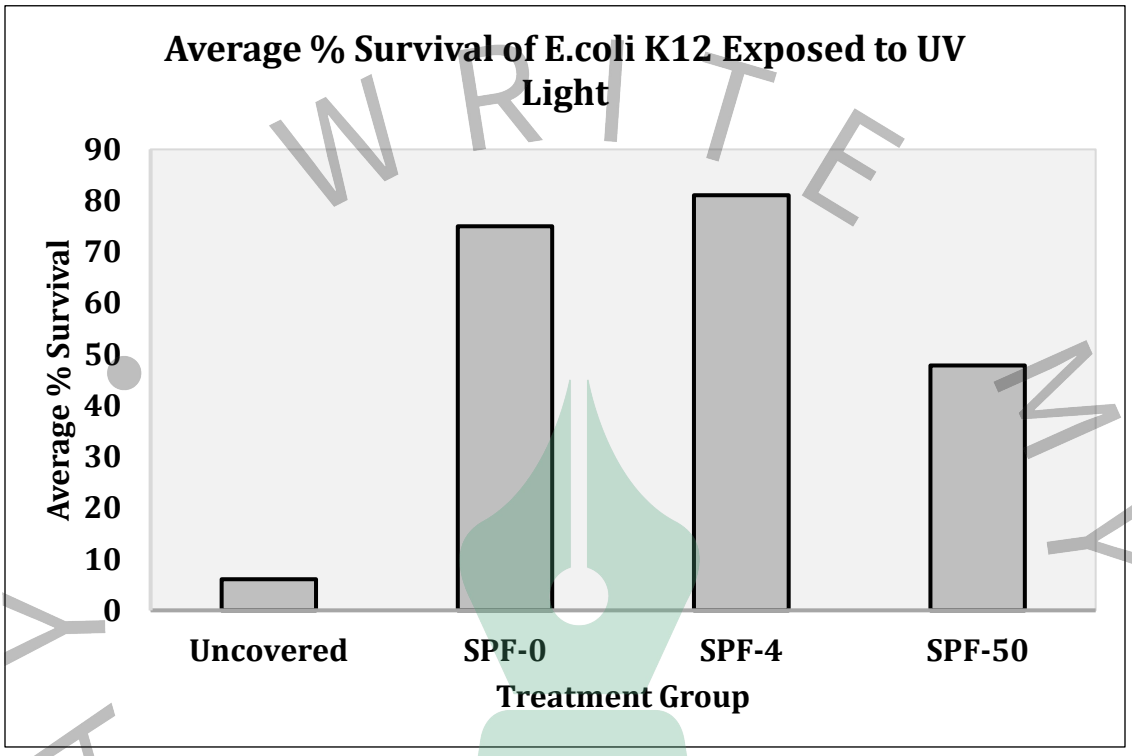

Figure 1. *SPF provides no greater protection from UV radiation than lotion.*

We found that applying lotion with SPF-0 resulted in a significant increase in E. coli survival relative to the no-treatment control (Figure 1); from 6 ± 10.5% in the no-treatment control sample, to 81± 35% in the SPF-0 sample (p=0.01). Increasing the SPF content gave no significant increase in E. coli survival and may even have decreased survival in control E. coli treated with the highest SPF. (Figure 1). The collected data suggest that SPFs provide no additional protection over lotion alone.

Discussion

Solar radiation in the form of UV rays poses a significant threat to human health. As a result, people are encouraged to protect their skin by wearing sunscreen. We hypothesized that sunscreens with higher SPFs would have greater UV blocking abilities, and thus protect E. coli from UV-induced DNA-damaging events. Under our experimental conditions, the application of lotion alone (SPF-0) was sufficient to block harmful UV rays, as evidenced by a significantly increased bacterial survival relative to the untreated control (Figure 1). Interestingly, however, sunscreens with higher SPFs provided no additional protection, as evidenced by no significant increase in bacterial survival, if compared to the lotion SPF-0.

Standard deviations ranging from 10-25% (Figure 1, error bars) suggest large variation in the data. Applying lotions to Saran Wrap is an imprecise method and open to variability. Indeed, differing thicknesses of lotion may allow for variance in the penetration and exposure to UV, even though care was taken to limit this variance.

Conclusion

Our data do not support our original hypothesis and suggest that SPFs provide no greater protection from harmful UVB rays than lotion alone.