

# Exposure to Visible Light Emitted from Smartphones and Tablets Increases the Proliferation of *Staphylococcus aureus*: Can this be Linked to Acne?

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## ABSTRACT

**Background:** Due to rapid advances in modern technologies such as telecommunication technology, the world has witnessed an exponential growth in the use of digital handheld devices (e.g. smartphones and tablets). This drastic growth has resulted in increased global concerns about the safety of these devices. Smartphones, tablets, laptops, and other digital screens emit high levels of short-wavelength visible light (i.e. blue color region in the visible light spectrum).

**Material and Methods:** At a dark environment, *Staphylococcus aureus* bacteria were exposed to the light emitted from common tablets/smartphones. The control samples were exposed to the same intensity of light generated by a conventional incandescent light bulb. The growth rate of bacteria was examined by measuring the optical density (OD) at 625 nm by using a spectrophotometer before the light exposure and after 30 to 330 minutes of light exposure.

**Results:** The growth rates of bacteria in both smartphone and tablet groups were higher than that of the control group and the maximum smartphone/control and tablet/control growth ratios were observed in samples exposed to digital screens' light for 300 min (ratios of 3.71 and 3.95, respectively).

**Conclusion:** To the best of our knowledge, this is the first study that investigates the effect of exposure to light emitted from digital screens on the proliferation of *Staphylococcus aureus* and its association with acne pathogenesis. Our findings show that exposure to short-wavelength visible light emitted from smartphones and tablets can increase the proliferation of *Staphylococcus aureus*.

## Keywords

Smartphones, Tablets, Blue Light, *Staphylococcus aureus*, Acne

## Introduction

The exponential rise in the use of handheld devices such as smartphones and tablets has raised global concerns about the safety of these devices [1-6]. Smartphones, tablets, laptops, and other LED screens can emit high levels of short-wavelength visible light (blue region in the light spectrum). Over the past several years, the biological effects of exposure to short-wavelength visible light emitted from smartphones and tablets on the eye and skin (disorders such as premature skin aging) have been widely studied. However, to the best of our

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knowledge, the effect of exposure to light emitted from these devices on the proliferation of *Staphylococcus aureus* and the possible association of these exposures with acne pathogenesis have not been investigated yet. Some studies show that *S. aureus* can intensify the symptoms in chronic inflammatory skin diseases. Acne vulgaris has been reported to be the most common human skin disorder. This skin disorder was reported to be persistent in 80% of the women (58% of these women had an ongoing need for treatment). Over the past several years, our laboratories at the non-ionizing department of the Ionizing and Non-ionizing Radiation Protection Research Center (INIRPRC) have conducted experiments on the health effects of exposure to different sources of electromagnetic fields such as cellular phones [7-14], mobile base stations [15, 16], mobile phone jammers [17, 18] and laptop computers [19]. We have also focused on the possible interactions between either ionizing or non-ionizing radiations as well as mechanical waves (e.g. ultrasound) and bacteria [20-23].

It has been revealed that exposure to bright light at night suppresses the secretion of melatonin and it has also been shown that human circadian system is susceptible to the biological effects of the short-wavelength part of the visible light spectrum [24, 25]. The application of blue light in different medical fields such as phototherapy [26, 27] or antibacterial treatment of plaque-induced periodontal pathologies [28] is well documented. It has recently been suggested to use screens with the emission peak of 470–480 nm instead of using screens with emission peaks below 450 nm. This suggestion is due to known risks associated with the exposure to blue light [29]. In this study, the effect of exposure to visible light generated by the screens of a commercial smartphone (Sony Xperia) and a commercial tablet (Samsung Galaxy Note 10.1) on the growth rate of *S. aureus* bacteria (ATCC No.

25923) is investigated.

## Material and Methods

All experiments were performed at 37°C in a separate incubator and bacteria were grown in 20 ml Brain Heart Infusion Broth (BHI) 10 cm plates. Then, in a dark environment, bacteria were exposed to the light of the tablet and smartphone at a distance of 2-3 mm (common distance between the smartphones and facial skin). The brightness of the displays of these devices was set at 50%. The control samples were exposed to the same intensity of light generated by a conventional incandescent light bulb. The growth rate of bacteria was examined by measuring the optical density (OD) at 625 nm by using a spectrophotometer (UNICO UV-2100 spectrophotometer) before the light exposure and after 30, 60, 90, 120, 150, 180, 210, 240, 300, and 330 minutes of light exposure.

## Results

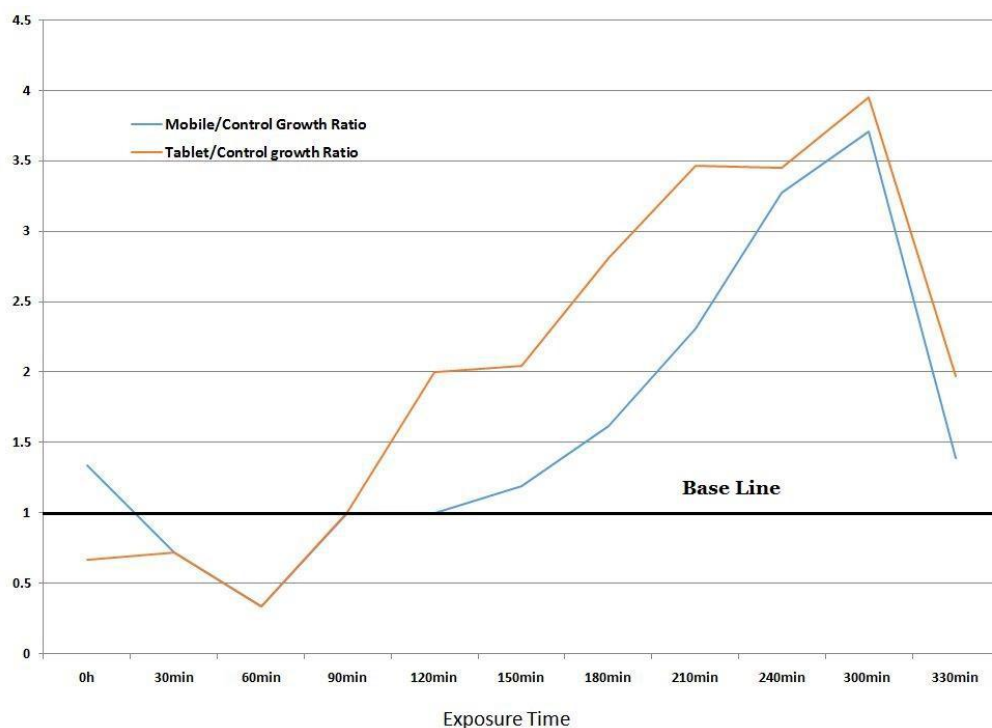
The growth rates of bacteria in both smartphone and tablet groups were higher than that of the control group. Optical density values in both smartphone and tablet groups before and after exposure to short wavelength visible light are summarized in Table 1. The maximum smartphone/control and tablet/control growth ratios were observed in samples exposed to digital screens' light for 300 min (ratios of 3.71 and 3.95, respectively). These ratios declined in samples exposed to screens' light for durations higher than 300 min. The growth rates of bacteria in both smartphone and tablet groups are shown in Figure 1.

## Discussion

Altogether, these findings show that exposure to short-wavelength visible light emitted from smartphones and tablets can increase the proliferation of *Staphylococcus aureus*. These findings are generally in line with the findings of our previous studies which showed the po-

**Table 1:** OD values before and after exposure to short wavelength visible light

Time	Optical Density (OD)				
	Control	Smartphone	Smartphone/ Control ratio	Tablet	Tablet/ Control ratio
0 min	0.003	0.004	1.33	0.002	0.66
30 min	0.007	0.005	0.71	0.005	0.71
60 min	0.003	0.001	0.33	0.001	0.33
90 min	0.005	0.005	1	0.005	1
120 min	0.008	0.008	1	0.016	2
150 min	0.026	0.031	1.19	0.053	2.03
180 min	0.021	0.034	1.61	0.059	2.80
210 min	0.013	0.03	2.30	0.045	3.46
240 min	0.029	0.095	3.27	0.1	3.44
300 min	0.038	0.141	3.71	0.15	3.95
330 min	0.137	0.19	1.38	0.27	1.97



**Figure 1:** The growth rates of bacteria in both smartphone and tablet groups were higher than that of the control group. This chart shows that the maximum smartphone/control and tablet/control growth ratios were observed in samples exposed to digital screens' light for 300 min (3.71 and 3.95, respectively).

tential interactions between either mechanical waves or electromagnetic radiation and bacteria [21-23]. We have previously shown that exposure of *Klebsiella pneumoniae* (*K. pneumoniae*) to electromagnetic radiation in the radiofrequency range can lead to a statistically significant rise in the susceptibility of this microorganism to different antibiotics. As in our study on *K. pneumoniae*, a minimum level of effect was needed for the induction of resistance after a pre-exposure, we postulated that the so-called “window theory” could be used for interpreting the findings [23]. This study was our first experiment on the effect of exposure to short wavelength visible light emitted from digital screens on the proliferation of *S. aureus*. Some studies have shown that treatment with visible light in the red region can be utilized as a therapeutic method to inactivate some pathogenic strains of porphyrin producing bacteria [30]. In this light, it seems that long wavelength red light and short wavelength blue light may have different effects on the growth rate of bacteria. This difference possibly reflects the role of visible photon energy on the proliferation of microorganisms. This theory should be verified by further experiments.

It is worth noting that the results obtained in this study cannot be entirely extrapolated to daily applications of smartphones because in this condition there are intense light sources such as sunlight or high intensity artificial sources of light which are much stronger than the light emitted from digital screens. As it is discussed in the materials and methods section, this study was conducted in a dark environment. In such an environment, digital screen’s light can be the only source of light. As today there are many people who use their smartphones in bed in a relatively dark condition, our study helps scientists better evaluate the response of bacteria to screens’ light in such a specific environment. However, due to limitations of this study, further studies are

needed to shed more light on the dark corners of the effect of digital screens’ light on the proliferation of different microorganisms and also to verify if these exposures can be linked to acne pathogenesis.

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### Conflict of Interest

None Declared.

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