Chapter 1

INTRODUCTION

1.1 Project Background

Normally, ultraviolet radiation (UVR) has become the main suspect of skin damage, specifically causing photoaging (Campiche *et al*., 2020). However, nowadays skin damage has been known to not only occur under ultraviolet exposure but also in the high energy visible (HEV) light that is also referred to as blue light. Blue light is a visible light that has a wavelength in the range of 400 to 500 nm and can be emitted from any electronic device such as computers, tablets, smartphones, and any other devices with an LED screen (Coats *et al*., 2021). In fact, a paper stated that the effect of visible light exposure may cause more sustained damage compared to UVA exposure (Cohen *et al.,* 2020).

In medical devices, blue light has been known to be useful in the medical field for treating cancer with its high energy, but when skin is excessively exposed to blue lights, this may lead to some damaging effects including hyperpigmentation and skin oxidative stress (Campiche *et al*., 2020). A paper from Sadowska, Narbutt, and Lesiak, 2021 also stated that the negative impact of Bluelight irradiation includes increasing ROS (Reactive Oxygen Species) by 147% and 53% of DNA damage. These unwanted effects might happen due to the activation of the photo acceptor in the skin, which will induce the production of ROS called superoxide thus damaging the dermis layer of the skin (Sadowska, Narbutt, and Lesiak, 2021). This damage that occurs results in the disruption of the epidermal barrier leading to skin aging (Ngoc *et al*., 2019). Moreover, in relation to hyperpigmentation, the exposure to blue light was assumed to trigger the melanogenic precursors in producing a photooxidative agent that lead to persistent pigment darkening (PPD) and immediate pigment darkening (IPD) (Campiche *et al*., 2020).

Due to its proven risk of damaging the skin, some sunscreen products have claimed photoprotective capability for their product to not only be able to protect against ultraviolet exposure but also protect the skin from exposure to blue light. The claim was based on the sunscreen's ability in providing a physical barrier to the skin by reflecting and scattering the light, thus protecting it from photooxidation. A recent study by Bernstein, Sarkas, and Boland (2020) showed that with the sunscreen product, the attenuation of HEV for the skin can reach up to 71.9 - 85.6%, while the unprotected skin showed only 3.9 - 4.9% HEV attenuation. Hence, it is suggested that the sunscreen product tested in this experiment also provides protection from blue light to the skin.

This increase in claims has been increasing alongside the current rise in online activity which results in increased usage of blue light-emitting electronic devices and exposure to blue light. Due to these increasing claims, there is a need to validate them through a scientifically proven and validated method. One of the many ways in substantiating these claims is by measuring the Bluelight protection capability of sunscreen products by utilizing *In vitro* HaCat cells test. HaCat is an immortalized keratinocyte cell in which this keratinocyte itself is responsible for helping the epidermis provide the skin structure by producing cytokines that are important in arranging cell communication for skin barrier functioning. Besides that, this *in vitro* method with HaCat cells has been commonly used in past studies to examine the effect of blue light exposure on cell viability and cell aging. One study found that blue light is toxic for keratinocyte cells as there was a decrease in the cells after irradiation every 24 hours in three consecutive days (Sadowska, Narbutt, and Lesiak, 2021). With this basis, the proposed methodology using immortalized keratinocyte cells is chosen to prove that the sunscreen product tested may provide cytoprotective ability against blue light.

The *in vitro* method in this experiment was chosen for not only being deemed more practical compared to clinical trials but also for providing no ethical concerns that arise from animal testing. Furthermore, previous research has provided evidence that a detrimental effect resulting from blue

light irradiation can be observed through *in vitro* cultured cells assays (Avola *et al*., 2019). Prior to the *in vitro* test, the optimization of the blue light exposure protocol will be conducted. Following the optimization, the cytotoxicity and the cell viability study will be carried out by examining the viability difference between the cells treated with the product towards HaCat cells and those without product treatment against the blue light exposure. Hence, in this study, it is expected that the cytoprotective ability of sunscreen product X would be able to be evaluated after the *in vitro* study is concluded.

1.2 Objectives

The objective of this research is to prove the claims of the tested sunscreen product for its protective ability against blue light through *in vitro* cell viability measurement using HaCat cells.

1.3 Scope of Work

The scope of work that will be carried out in the experiment includes HaCat cell culture, miscibility test of the product, optimization of blue light exposure to the cells, and cytotoxicity study of the products through cell viability measurement. After all necessary parameters have been optimized, the cytoprotective study against blue light exposure will be determined by measuring the cell viability of cells after blue light exposure with or without product treatment using MTS assay.

1.4 Hypothesis

The hypotheses of this study are:

1. HaCat cells will maintain cell viability after treatment with sunscreen product at an optimum product concentration
2. The treatment of HaCat cells with sunscreen product will result in higher cell viability compared to non-treated HaCat cells post-exposure to blue light.