I. INTRODUCTION

1.1 Background

Ultraviolet (UV) radiation, a form of energy emitted by the sun, has both positive and negative effects on the skin (WHO, 2022). While necessary for vitamin D production, overexposure to UV radiation can lead to skin damage, premature aging, and skin cancer (Heinrich et al., 2011). UVA, UVB, and UVC are the three types of UV radiation, with both UVA and UVB capable of causing skin damage. However, UVB rays are particularly harmful, causing sunburns, skin cancer, and premature aging (CDC, 2023). According to the World Health Organization (2022), the extent of damage depends on UV ray intensity and exposure duration without protection. UVB, specifically, can induce adverse effects, leading to DNA alterations in the skin, contributing to skin cancer development and premature aging, known as photoaging (Gromkowska-Kępka et al., 2021). Photoaging results from prolonged exposure to ultraviolet (UV) radiation over one's lifetime, predominantly sourced from solar radiation. It manifests in distinctive features including wrinkle formation, alterations in pigmentation, diminished skin tone, uneven and coarse skin texture, the occurrence of broken capillaries, as well as the presence of redness and blotchiness (CDC, 2022). Exposure to UV radiation has the potential to induce an inflammatory reaction in the skin, resulting in redness and irritation (Xue et al., 2022). Piquero-Casals et al. (2023) posit that UV radiation exposure can precipitate or exacerbate acne, with UV light eliciting post-inflammatory hyperpigmentation/erythema and inciting flares, yet concurrently exhibiting a transient ameliorative effect on acne lesions (Chen et al., 2023; Piquero-Casals et al., 2023). The author asserted that excessive exposure to UV radiation can prompt proinflammatory and profibrotic reactions, resulting in the development of post-inflammatory hyperpigmentation and/or post-inflammatory erythema.

Preventing overexposure to sunlight is crucial to reduce the risks of cancers, premature skin aging, cataracts, and other harmful effects (Cleveland Clinic, 2022). Widespread recommendations emphasize the daily use of photoprotection, as sunscreens play a significant role in improving

symptomatology, enhancing treatment, and preventing post-inflammatory hyperpigmentation (Piquero-Casals et al., 2023). Sunscreen formulations may combine physical photoprotective components like titanium dioxide (TiO2) and zinc oxide, reflecting or scattering UV light, with chemical agents such as p-amino benzoic acid (PABA), PABA esters, cinnamic, salicylate, anthranilate, oxybenzone, benzophenone, and polyphenolic compounds that absorb UV light, preventing its penetration into the skin (Nurwaini et al., 2021; Gabros, 2023). While sunscreen effectively attenuates ultraviolet radiation, it lacks the potential to address reactive oxygen species (ROS), necessitating the addition of an antioxidant extract (Jesus et al., 2023).

Green tea, a source of polyphenolic compounds such as epigallocatechin gallate (EGCG), serves as an antioxidant agent studied for its ability to neutralize free radicals and alleviate oxidative stress (Senanayake, 2013). Oats, another plant-based source of antioxidants, contain significant quantities of phenolic compounds, specifically Avenanthramides (Kim et al., 2021). Avenanthramides, a unique group of polyphenols in oat, exhibit inhibitory effects on pro-inflammatory cytokines, enzymes, and signaling pathways, attenuating the inflammatory response (Perrelli et al., 2018). Furthermore, by scavenging free radicals and preventing lipid peroxidation, avenanthramides have potent antioxidant activity (Xue et al., 2021).

The objective of this study is to assess the synergistic effects of combining green tea and oat extracts as antioxidant compounds for potential use in skincare products, evaluating their cytoprotective activity against UVB. The study results will lay the groundwork for formulating a sunscreen that not only protects the skin from UVB radiation but also addresses inflammation, a common challenge for individuals dealing with acne.

1.2 Objective

The study was done to evaluate the synergistic of green tea and oat extract of their cytoprotective activity against UVB radiation. The assessment was done through *In vitro* study on HaCaT cells whose cytoprotective activity was measured through MTS assay.

1.3 Hypothesis

The hypothesis of the study are as follows:

- Green tea and Oat extract has antioxidant properties
- In the presence of green tea and oat extracts, synergistic cytoprotective activities against UVB irradiation will be observed *In vitro* towards HaCaT cells

1.4 Research scope

The scope of work of this research includes:

- Examination of the green tea and oat extract antioxidant property through the DPPH assay
- HaCaT cell culture
- Cytotoxicity assay of green tea, oat extract, and ascorbic acid
- Cytotoxicity assay of combined green tea and oat extract
- Cytoprotective assay of combined green tea and oat extract
- Cell viability assessment using MTS assay
- Statistical analysis of the acquired data and formulation of a comprehensive report based on the results