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Potential Dutch Eggplant Peel (*Solanum betaceum*) as H_2O_2 Scavenging and Antiaging Activity

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Abstract

Background: Aging is a process of decreasing cell development that can be caused intrinsically and extrinsically and that triggers Reactive Oxygen Species (ROS) production. An unstable ROS triggers an increase in hydrogen peroxide (H_2O_2) and elastase activity, which subsequently accelerates aging. Dutch eggplant fruit (*Solanum betaceum*) is now a concern because it has a good content of phenol compounds and flavonoids for enhancing antioxidant and antiaging. **Objective:** This study aims to analyze antioxidant through H_2O_2 scavenging and antiaging through anti-elastase activity of *S. betaceum* peel extract (SBPE). **Methods:** The research method *S. baceum* peel was extracted using the maceration method with solvent 70% ethanol. Antioxidant assay occurs through H_2O_2 scavenging assays, while antiaging assay through elastase inhibition. **Results:** The SBPE had H_2O_2 scavenging activity with Median Inhibition Concentration (IC_{50}) 175.39±11.27 µg/mL and an IC_{50} elastase inhibition activity was 50.18±0.66 µg/mL. **Conclusion:** SBPE has an antioxidant through H_2O_2 scavenging and anti-aging through elastase inhibition.

Key words: *Antioxidants, Antiaging, Reactive Oxygen Species, Solanum Betaceum*

Introduction

Throughout the progression of growth, development, and maturation of the body, aging represents a phase during which tissues and organs undergo degenerative alterations, marked by a gradual decrease in physiological functions (Xue et al., 2017). A very visible example of the onset of aging is on the skin, which is characterized by the appearance of wrinkles, spots, and a slender face (Rizkyah & Karimah, 2023). There are two factors that play a role in aging: an intrinsic factor, such as genetic or hormonal, and an extrinsic one that comes from outside the body as an environmental carcinogen, such as air pollution and exposure to ultraviolet (UV) rays (Kerns et al., 2019).

UV radiation and air pollution are the main sources of exogenous oxidation and the formation of free radicals that can accelerate aging due to changes in the structure of the dermis (Plainfossé et al., 2018; Ndlovu et al., 2013). An abundance of active reactive oxygen species (ROS) can affect to tissue, cellular and enzyme damage through oxidation, as well as be involved in a variety of aging-

related diseases (Liu et al., 2018; Zhang et al., 2018). Hydrogen peroxide (H_2O_2) is involved in the generation of energy in several living systems, such as signal transmission intercellular, cell development regulation, and the generation of main biological component (Packer et al., 2008). H_2O_2 is generated as a secondary outcome of aerobic metabolism and its levels are elevated during situations of infection, physical activity, and stress circumstances (Mukhopadhyay et al., 2016). The negative effects caused by ROS imbalance can be prevented with antioxidants (Widowati et al., 2018).

Elastase plays a role in the breakdown of elastin, or the protein that gives elasticity to the tissue that is abundantly exposed to the dermis layer of the skin and is responsible for sticking or shrinking the skin (Brilan, 2022). However, when its production is excessive, it can lead to the pathophysiology of some diseases, such as inflammation and atherosclerosis (Zeng et al., 2022). Nowadays, numerous skincare products or tretaments to prevent aging and maintaining skin elasticity may induce mild side effects like allergies, while some pose health risks and and negative impacts in the long term (Arbab and Eltahir, 2010). Consequently, there is a need for careful monitoring of the circulation of numerous beauty products, as many of them contain chemicals that pose potential harm to users. Therefore, the medical community is turning to scientifically proven plants that possess antioxidant and anti-aging properties (Mawarni et al., 2020). *Ageratum conyzoi* (Sutjiatmo et al., 2020), leaf and rose recepatakel (Mawarni et al., 2020), black soybeans (Irwan et al., 2020), *Jasminum sambac* (Widowati et al., 2018b), and dragon fruit (Liana et al., 2019). Many research reports have noted that antioxidants can prevent cell damage and inhibit premature aging of the skin (Sadowska-Bartosz & Bartosz, 2014).

Dutch eggplant (*Solanum betaceum*) or familiar with name Tamarillo is a plant in the Solanaceae family that originates from South America and is now widespread in Central America, Southern Europe and Oceania. (Canhoto et al., 2005). Currently, many farmers are cultivating one of them in the Karo region, North Sumatra, with yield data in 2011 reaching 482,305 tonnes with a high increase to 545,646 ns (Sudiono et al., 2023). Tamarillo is rich in protein, vitamins and minerals but low in carbohydrates and calories, and is widely used as a food to be eaten raw or made into juice and jam (Wang et al., 2020). Phenolic compounds, anthocyanins and carotenoids contained in the skin of tamarillo have been reported by many researchers as having biological and therapeutic benefits (Hurtado et al., 2009; Mertz et al., 2009). Previously, Deep et al., (2020) also tested the content of tamarillo peel as an antioxidant in three different varieties, namely Amber, Laird's Large, and Mulligan, all three of which were reported to contain the active compounds chlorogenic acid, caffeic acid, p-coumaric acid, and ferulic acid, gallic acid, ellagic acid, kaempferol, catechin, epicatechin, routine, and anthocyanin. Based on reports, the content contained in tamarillo skin is believed to have antioxidant as well as anti-obesity (Abdul et al., 2015), anti-cancer (Mutalib et al., 2017), and antimicrobial activity (Ordóñez et al., 2006). Based on this, the research focused on analyzing the effectiveness of antioxidants through H_2O_2 scavenging and anti-elastase activities from *S. betaceum* peel extract (SBPE) as an alternative to prevent premature aging.

Materials and Methods

Extraction preparation of S. betaceum peel

S. betaceum is found at the Berastagi fruit market, Karo district, North Sumatra, Indonesia. The plant has been identified at the Biology Herbarium Laboratory, Institut Teknologi Bandung, West Java, Indonesia. The peel of *S. betaceum* fruit (2000 g) was dried and mashed into powder (100 g). Briefly, the powder of *S. betaceum* peel was extracted using ethanol 70% with a total volume 1,200 mL by maceration method. The filter was collected every day, and the remaining filtrate is re-macerated. The yield of extract produced of 5.45 g and was kept cold for additional testing at -20 ^{0}C (Widowati et al., 2023).

H_2O_2 scavenging activity assay

This evaluation was conducted using a methods by Jusri et al. (2019) and Liana et al. (2019) with modification. The varying final concentration of the sample SPBE were mixed with ferrous ammonium sulfate and H_2O_2 in 96 well plate. The control well is consisted with DMSO 10% and ferrous ammonium sulfate. The mixture was then incubated in a dark light for 5 minutes at room

temperature. Subsequently, 1,10-phenanthroline (1 mM) was added to each sample and control well, followed by another incubation under the same conditions for 10 minutes. The absorbance was measured at 510 nm (Jusri et al., 2019; Liana et al., 2019; Prahastuti et al., 2020). The scavenging activity percentages of the samples were determined using the formula provided (1):

$$H_2O_2 \text{ scaveging activity } (\%) = \frac{control\ absorption - sampel\ absorption}{control\ absorption}\ x\ 100 \quad (1)$$

Elastase inhibition assay

The assay was measured using to the previous modified technique by (Mawarni et al., 2020; Widowati et al., 2017; Girsang et al., 2020; Juliana et al., 2020). A total of 10 mL of SPBE samples of 2.08, 4.17, 8.33, 16.67, 33.33, 66.67 µg/mL respectively, were added to the sample well. After that, five microlitres of the enzyme elastase was dropped into the control well and the sample well. The Tris HCl pH 8 buffer (130 µL) was added to the blank well, 125 µL to the sample well, and 135 µL to the control well, incubated for 15 minutes at 25°C. After incubation, 10 µL of SucAla3-pNa was added to all test wells, and reincubated for 15 minutes at a temperature of 25°C using a rotator. The observation was done by calculating the absorption using a microplate reader at 410 nm. The percentage of the calculation of the elastase inhibition activity can be seen on the equation (2):

$$\text{Elastase inhibition activity } (\%) = \frac{control\ absorption - sampel\ absorption}{control\ absorption}\ x\ 100 \quad (2)$$

Statistical analysis

The data analysis was using software SPSS version 20.0, the value is presented as an average and the standard deviation. Significant differences were identified using one-way ANOVA, followed by Tukey's post-hoc HSD test and statistically significant differences considered with a p-value of <0.50. H_2O_2 scavenging and anti-elastase activities were evaluated through linear regression, and IC_{50} was determined as a 50% inhibition concentration value.

Results and Discussion

H_2O_2 scavenging activity

The H_2O_2 assay was performed by spectroscopic photometry**.** The amount of H_2O_2 scavenging activity was performed in histogram, SPBE showed that the best scavenging activity was found at concentration of 1000 µg/mL (80.76%) and the lowest activity (30.25%) at the concentration of 15.625 µg/mL **(Figure 1)**. Based on **Table 1** SPBE has IC_{50} value of 175.39±11.27 µg/mL. This study showed that H_2O_2 scavenging activity coincided with an increase in concentration, which significantly difference among SBPE group (P<0.05).

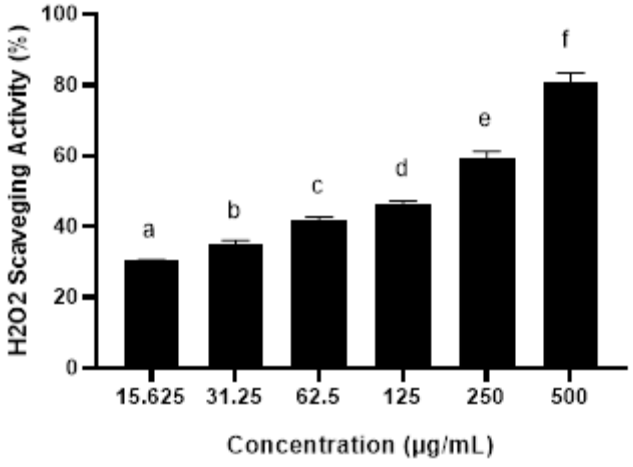

Figure 1. The effect of SBPE toward H_2O_2 scavenging activity

*SBPE concentration: I : 15.625; II : 31.25, III : 62.5; IV : 125; V : 250; VI : 500 µg/mL. Data is presented as a mean ± SD. Different symbols (a, b, c, d, e, and f) is showing a significant difference among sample concentration (p <0.05) based on the Tukey HSD post hoc test.

Table 1. Average value of IC_{50} H_2O_2 scavenging activity at various SBPE concentrations

Sample	Linear regression	R2	IC_{50} (µg/mL)	IC_{50} Average (µg/mL)
SPBE (repetion 1)	y = 0.0934x + 32.679	0.98	185.45	175.39±11.27
SPBE (repetion 2)	y = 0.1003x + 32.196	0.98	177.51	
SPBE (repetion 3)	y = 0.1040x + 33.027	0.98	163.20	
SPBE (average)	y = 0.0992x + 32.634	0.99	175.06	

Elastase inhibitory activity

The elastase inhibitory capacity of SPBE is shown in this study (**Figure 2).** The concentration of 66.67 µg/mL showed the highest percentage with value of 56.79% while the lowest activity showed in the concentration of 31.25 µg/mL with value of 2.08% ($P<0.05$). As for the IC_{50} value average on SBPE on elastase inhibition activity was 50.18±0.66 µg/mL, it can be seen at **Table 2.** This indicated the SPBE has antiaging activity.

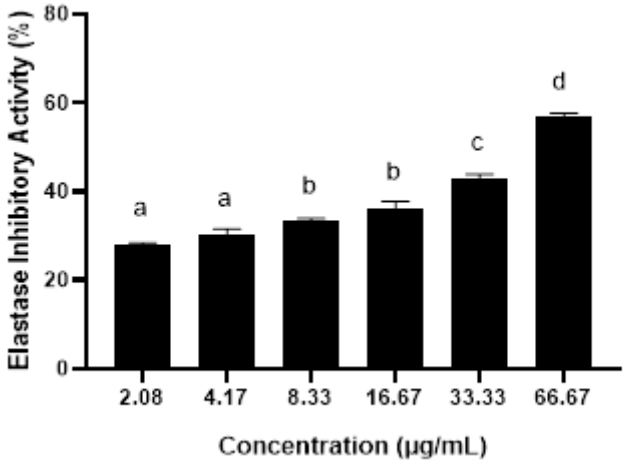

Figure 2. The effect of SBPE toward elastase inhibition activity

* SBPE concentrations: I : 2.08; II : 4.17; III : 8.33; IV : 16.67; V : 33.33; VI : 66.67 µg/mL. Data is presented as a mean ± SD. Different symbols (a, b, c, and d) is showing a significant difference among sample concentration ($p <0.05$) based on the Tukey HSD post hoc test.

Table 2. Average value IC_{50} of elastase inhibition activity towards various SBPE concentrations

Sample	Linear regression	R2	IC_{50} (µg/mL)	IC_{50} Average (µg/mL)
SPBE (repetion 1)	y = 0.4392x + 28.283	0.99	49.45	50.18±0.66
SPBE (repetion 2)	y = 0.4026x + 29.582	0.98	50.72	
SPBE (repetion 3)	y = 0.4348x + 28.098	0.99	50.37	
SPBE (average)	y = 0.4255x + 28.654	0.99	50.17	

DISCUSSION

Reactive Oxygen Species (ROS) is identified as a causative factor in accelerating skin aging. ROS generates free radicals due to exposure to air pollution, thereby initiating oxidation reactions leading to increased levels of H_2O_2 and elastase, thus promoting skin aging (Kumaresan et al., 2015). To prevent aging, antiaging treatments with antioxidants are necessary. Antioxidants are believed to neutralize ROS (Widowati et al., 2018b). Natural antiaging properties can be obtained through antioxidants present in a healthy diet. The antioxidant abilites of plants has been largery studied. Tamarillo peel has been evaluated in this research because its fruit is widely consumed

by the public and believed to contain Vitamin C, which can treat tuberculosis and boost immunity (Djufry et al., 2016). Other compounds such as phenols, flavonoids, and anthocyanins are also abundant in the peel of *S. betaceum*, which potentially act as antioxidants and antiaging agents (Dewi, 2020). Therefore, the focus of this study is to observe *S. betaceum* peel extract (SBPE) as an antioxidant and antiaging agent.

Several oxidizing enzymes, including superoxide dismutase (O2*-), have the ability to penetrate cell membranes and gradually oxidize various substances within living organisms, leading to the generation of H_2O_2 in the body (Özen et al., 2008). The presented study showed SBFE has scavenging activity of H_2O_2 with value of 80.76%; IC50=175.39±11.27 µg/mL (Figure 1, Table 1). In this case, the SBPE IC_{50} belongs to the weak category based on testing results of H_2O_2 scaveging activity. The presence of an IC_{50} value within an antioxidant, known for its anti-aging properties, serves as a determining factor, as it indicates the concentration required to neutralize 50% of the free radicals within the body (Siswarni et al., 2017). The common category of IC_{50} is at values < 50 µg/mL, classified to be very strong, 50-100 µg/mL strong, 100-150 µg/mL moderate, and 150-200 µg/mL weak (Supriyanto et al., 2017). This result are correspondence with Utami (2021) reported that, *S. betaceum* peel extract has an antioxidant activity with IC_{50} of 304.47 µg/mL evaluated bu DPPH assay. Dewi (2020) study also reported that *S. betaceum* peel extract with the same method showed IC_{50} value of 1347.28 ppm. *S. betaceum* peel extract has antioxidant activity due to DPPH scavenging with IC_{50} value 47.95 ppm which is included in the very active category (Silitonga et al., 2024). Meanwhile, using a different method on *S. betaceum* peel using the FRAP method has been reported by Noor Atiqah et al. (2014) with an antioxidant yield of 12.17 µM Fe (II)/g. Ramadan (2015) stated that the cause of differences in antioxidant results in each study was due to different varieties, concentrations and maceration processes. The maceration process with a longer time allows the sample to have a smaller IC_{50} content, which indicates a greater potential for antioxidant activity (Ramadan, 2015).

Elastase inhibition can reduce inflammation and prevent further damage to injured tissues (Wahart et al., 2022). In this study, SPBE has inhibition of elastase activity 56.79%, with an IC50 value of 50.18±0.66 µg/mL (Figure 2, Table 2). Based on the Silitonga et al. (2024), *S. betaceum* peel extract has total polyphenol content and total flavonoid content with values of 66.6242 mg GAE/g and 7.4246 mg QE/G extract, respectively (Silitonga et al., 2024). The inhibition of elastase by SBPE is due to the existence of flavonoids and phenolic substances, specifically flavones, flavonols, isoflavones, and anthocyanins, which are believed to contribute to scavenging free radicals, thereby serving as antioxidants (Widayanti et al., 2016). Based on another study, *Ziziphus mistol* and *S. betaceum* peel waste as antiaging agents showed that *S. betaceum* peel extract exhibited greater ability to inhibit elastase and tyrosinase activity compared to *Z. mistol* (Orqueda et al., 2022). The mechanism of elastase activity inhibition with SBPE may occur through an enzymatic and through non-enzymatic reactions. The enzymatic reaction involves enzymes such as catalase, superoxide dismutase (SOD), and others, while the non-enzymatic reaction collaborates with its active compounds such as anthocyanins, which work to protect the skin from UV-B radiation (Liu et al., 2018). Flavonoids bind to metal ions that form ROS and enhance endogenous antioxidants (Yusharyahya, 2021). These antioxidants contribute electrons to neutralize chain reactions of damage within the body and activate enzyme regulation to control the production of free radicals, thus preventing aging (Rahmawati et al., 2020). The contained antioxidants can regulate gluconeogenesis and affect collagen and elastin levels (Yu et al., 2022).

Conclusion

SBPE exhibits antioxidant activity through H_2O_2 scavenging activity. SBPE also has antiaging properties through elastase inhibition activity based on *in vitro* studies. Furthermore, this study suggesting that SBPE has potential as an antioxidant and anti-aging agent.

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