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Evaluation of Antioxidant and Anti-psoriatic Activities of Purple Sweet Potato (*Ipomoea batatas* L.) Leaves Aqueous Extract on Imiquimod-induced Psoriasis-like Dermatitis

Santhra Segaran Balan[1], Hasnah Bahari[2], Nur Afiqah Arjunaidie[3], Sabariah Md. Noor[4], Nurkhasanah Mahfudh[5], and Fezah Othman[3]*

[1]Department of Diagnostic and Allied Health Science, Faculty of Health and Life Sciences, Management and Science University, Shah Alam, Malaysia
[2]Department of Human Anatomy, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
[3]Department of Biomedical Sciences, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
[4]Department of Pathology, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
[5]Faculty of Pharmacy, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Psoriasis is a chronic autoimmune skin disease that affects the quality of life. Psoriasis also is one of the most unpredictable and currently incurable diseases. Conventional therapy using corticosteroids, vitamin D analogs, calcineurin inhibitors, and cytotoxic agents is associated with a low success rate, and prolonged use causes side effects. Thus, the discovery of more effective anti-psoriatic drugs with a minimal side effect is currently an active research area. In Malay traditional medicine, the leaf part of sweet potato (*Ipomoea batatas*) has been claimed as anti-psoriatic. In this study, we evaluated the antioxidant and anti-psoriatic effects of an aqueous extract of purple sweet potato leaves (PSPLAE) on psoriasis-like skin inflammation induced by imiquimod (IMQ) in BALB/c mice. This study examined various antioxidant-related phytochemical components in PSPLAE, specifically the total phenolic content (TPC) and total flavonoid content (TFC). The antioxidant capacity of PSPLAE was assessed utilizing the 2,2-diphenyl-1-picryhydrazyl (DPPH) free radical scavenging method. The plant extract was then applied to an IMQ-induced psoriatic BALB/c mouse model to evaluate the efficacy of PSPLAE against psoriasis-like dermatitis. Treatment was administered topically for 15 d using PSPLAE cream at concentrations of 5, 10, and 20%, and the psoriasis area severity index (PASI) was calculated. In the phytochemical analysis, PSPLAE exhibited the corresponding values of 7.62 ± 1.91 mg GAE/g dry extract (DE), and 2.74 ± 0.85 mg QE/g DE for TPC and TFC, respectively. In addition, the antioxidant activity of PSPLAE, determined by the DPPH assay showed lower activity (EC_{50} = 244.8 ±13.6 µg/mL) when compared to the ascorbic acid standard (EC_{50} = 47.3 ±8.9 µg/mL). Interestingly, the antioxidant activity was found positive (r = 0.59) (moderated association) correlated with the TPC. As for the *in vivo* study, the effect of PSPLAE cream on the IMQ-induced psoriatic mouse model showed a dose-dependent response as evident through the PASI grading. This study demonstrated the anti-psoriatic effects of *I. batatas* leaf aqueous extract in mitigating IMQ-induced psoriasis-like skin inflammation in BALB/c mice. These findings suggest that *I. batatas* leaves may serve as a cost-effective source of natural antioxidants with potential anti-psoriatic properties.

Keywords: DPPH radical scavenging assay, imiquimod, *Ipomoea batatas*, psoriasis, psoriasis area and severity index (PASI)

*Corresponding author: fezah@upm.edu.my

INTRODUCTION

Psoriasis is considered a non-communicable and chronic inflammatory skin disease that affects the quality of life of a patient. Psoriasis is distinguished by white scales and is strongly described as the formation of erythematous plaques. Other than that, psoriasis also has been defined as a genetic and immune-mediated disease that can occur in the joints, skin, or both (Boehncke and Schön 2015). Psoriasis also has been linked with some comorbidities that need to be appropriately diagnosed and managed. The risk factor of psoriasis is classified into two categories, which are internal and external risk factors (Kamiya *et al.* 2019). Internal risk factors include obesity, diabetes mellitus, dyslipidemia, hypertension, and mental stress. Besides that, the external risks also such as include mechanical stress, air pollution, hot sun exposure, drugs, vaccination, infection, and lifestyle.

The diagnosis of psoriasis is usually done by observation of the erythematous scaly patches, plaques, and papule presence, which is often painful and pruritic. The classification of psoriasis can be categorized into plaque-type psoriasis, inverse psoriasis, erythrodermic psoriasis, localized pustular psoriasis, and guttate psoriasis (Weigle and McBane 2013). The most common type is plaque-type psoriasis. It also can occur in non-dermatologic areas such as nails (psoriatic onychodystrophy) and psoriatic arthritis. Psoriasis is characterized by persistent inflammation, which results in uncontrolled keratinocyte growth and defective differentiation. According to Rendon and Schäkel (2019), the growth of keratinocytes was activated by the inflammatory mediators through tumor necrosis factor-α (TNF-α), interlukin-17 (IL-17), and interferon-gamma (IFN-γ). Other than that, LL37-DNA complexes also trigger the activation of keratinocytes and lead to the increased secretion of type I IFNs. Furthermore, these entities actively participate in the inflammatory process through the release of cytokines (including IL-1, IL-6, and TNF-α), chemokines, and AMP.

Currently, there are a variety of therapies or medications that are available to cure or manage psoriasis. The treatment needed for psoriasis depends on its severity. The severity of the disease is determined by the condition of the lesion, the percentage of body area affected, and how psoriasis affects the patient's quality of life (Mrowietz *et al*. 2011). Corticosteroids, vitamin D3 analogs, and calcineurin are examples of conventional therapies and currently were used as a topical treatment for mild psoriasis (Takuathung *et al*. 2018). Menter *et al*. (2009) discussed that phototherapy or systemic medicines such as methotrexate, cyclosporine, and acitretin are frequently used to treat severe psoriasis. Other than that, biological therapies for psoriasis also have been developed and approved, whereby they will play a role in the upregulated cytokine pathways. In several studies, antioxidant activity has also been proven to have a positive effect on the treatment of psoriasis. However, there are studies that report that most of these treatments have a well-documented list of side effects that appear to be the primary reason preventing patients from complying with long-term treatment of psoriasis, indicating a need for the development of a medicine with improved efficacy but fewer side effects.

Sweet potato, or its scientific name *Ipomoea batatas* L., is commonly known as "nyamis" (Africa), "kumara" (New Zealand), and "camote" (southwest United States) (Hue *et al.* 2012).. A study done by Zhang *et al*. (2019) describes that purple sweet potato leaf (PSPL) extract expresses a broad range of activities that help to improve health such as anti-oxidative, anti-cancer, anti-diabetic, anti-bacterial, and anti-inflammation activity. These pharmacological activities have been reported to be strongly related to the bioactive compounds that appear in leaf extract (Nguyen *et al.* 2021). The main purpose of this study is to investigate the effectiveness of *Ipomea batatas* in curing psoriasis-like skin disorders.

MATERIALS AND METHODS

Collection and Preparation of *Ipomoea batatas* L.

The purple sweet potato leaves were obtained from the industrial sweet potato plantation in Sungai Pelek, Sepang, Selangor, Malaysia. The samples were verified by the Institute of Bioscience of the University of Putra Malaysia (UPM; Plant Voucher Number: MFI0188/20). Then, the PSPLs were frozen at –80 °C and freeze-dried by using a freeze dryer, crushed into fine powder, and kept at room temperature.

Extraction of Aqueous *Ipomoea batatas* Leaf

The extraction for aqueous extract was prepared according to the technique by Balan *et al.* (2019). Fifty grams (50 g) of *Ipomoea batatas* dried leaf powder was put in a conical flask comprising 500 mL of distilled water. This solution was thoroughly mixed and placed into the water bath for 24 h at 80 °C. Then, the PSPL aqueous extract was filtered by using Whatman's filter paper No. 1. Under the same condition, the residues were re-extracted and repeated four times. Next, all the filtrates were combined and were dried by using an oven at 45 °C. Then, the obtained extract was weighed, recorded, and kept in the –20 °C freezer prior to freeze drying. The volume of extract was measured; the percentage of extraction yield was estimated using the formula:

Table 1. The required amounts of PSPLE and base cream to prepare 10 g of each cream concentration (5, 10, and 20%, w/w).

PSPLE cream concentration (%)	PSPLE (g)	Base cream (g)	Total (g)
5	0.5	9.5	10
10	1.0	9.0	10
20	2.0	8.0	10

$$\text{Yield (\%)} = \frac{m\ (Extract)}{m\ (Fine\ powder)} \times 100,$$

where "m (extract)" is the mass of the extract (g), and "m (fine powder)" is the mass of SPL powder.

Preparation of Purple Sweet Potato Leaf (PSPL) Cream

The PSPLAE cream was prepared by homogeneously mixing the plant extract with a cream base (Popoemart, Malaysia), following the previously described method (Navindgikar, Kamalapurkar, and Chavan 2020). The cream base is free of fragrance and contains only purified water, cetearyl alcohol, glycerine, and phenoxyethanol. Table 1 shows the required amounts of PSPLAE and cream base to produce 5, 10, and 20% (w/w) PSPLAE cream.

Total Phenolic Content (TPC)

The TPC was established using the Folin-Ciocalteau assay based on Park and Lee (2024) with some alterations. Samples or a standard (20 µL) that have been diluted with distilled water (1 mg/mL) were combined with 100 µL of diluted Folin-Ciocalteau reagent (1:10, v/v in distilled water) in a 96-well plate. After 5 min, 80 µL of 7.5% sodium carbonate (Na_2CO_3) was put into each well. All reagents were mixed thoroughly with a vortex mixer before being added to the well. The sample was protected from light exposure and maintained in an undisturbed state on the laboratory surface for a duration of 30 min. Subsequently, the absorbance was measured at 765 nm relative to a reagent blank utilizing a spectrophotometer. A standard calibration curve using gallic acid (7.8–500 µg/mL) was plotted, and all findings were done in triplicate and were conveyed as mg gallic acid equivalent (GAE)/ g dry extract (DE) extract using the following formula:

$$\text{TPC for 1 g of extract} = \frac{\textit{TPC per mL sample x Dilution factor x Total sample volume used}}{\textit{Sample weight}} \quad (1)$$

Total Flavonoid Content (TFC)

The TFC was measured using an aluminum chloride colorimetric assay based on the method used by Belguith-Hadriche *et al*. (2013) with some adjustments. Samples or a standard (25 µL) that have been diluted with distilled water (1 mg/mL) were mixed with 100 µL of distilled water (dH_2O) in a 96-well plate. Consequently, 7.5 µL of 5% $NaNO_2$ was added to the mixture. After 5 min, 7.5 µL of 10% $AlCl_3.6H_2O$ were added. The mixture was maintained at room temperature for an additional 5 min. Subsequently, 50 µL of 1M NaOH was added. Immediately thereafter, 60 µL of dH2O was introduced to the mixture, and the absorbance was measured at 510 nm using a microplate reader against a blank. All reagents were thoroughly homogenized using a vortex mixer prior to their addition to the well. A standard calibration curve using quercetin (125–1000 µg/mL) was plotted, all results were done in triplicate and expressed as mg quercetin equivalent (QE)/ g DE using the formula:

$$\text{TPC for 1 g of extract} = \frac{\textit{TPC per mL sample x Dilution factor x Total sample volume used}}{\textit{Sample weight}} \quad (2)$$

Antioxidant Assay: 2,2-Diphenyl-1-picrylhydrazyl (DPPH)˙ Radical Scavenging Assay

The DPPH radical scavenging capacity was established according to Kong *et al*. (2012). Samples or a standard (50 µL) that have been diluted with methanol in 1 mg/mL to prepare at various concentrations (3.9–250 µg/mL) were mixed with 195 µL of DPPH solution (100 µM in methanol) in a 96-well plate and left in the darkroom at room temperature for 30 min. All reagents were mixed thoroughly with a vortex mixer before being added to the well. The absorbance of the reaction mixture was read at 515 nm. Butylated hydroxytoluene (BHT) was utilized as standard. The scavenging capacity of the sample was evaluated using the following equation:

$$\text{Scavenging capacity (\%)} = \frac{A0-(A1-A2)}{A0} \times 100\%$$

where A0 is the absorbance of the control group (sample solution was substituted by extraction solvent), A1 is the absorbance of the sample or standard, and A2 is the absorbance of the blank sample (DPPH solution was substituted by methanol).

All results were done in triplicate and presented as EC_{50}, which is the effective concentration of samples and standards that scavenge 50% of DPPH radicals after a specified exposure time.

Animal Ethics Application

All experiments were done by following the OECD guidelines (No. 442B 2017) for the testing of chemicals. The

procedure has been approved by the Institutional Animal Care and Use Committee of Management and Science University (MSU; EA-L3-01-FHLS-2024-01-0002).

Animal Experimental Design

Forty-two (42) male BALB/c mice (weighing 20–30 g) at the age of 8–11 wk were utilized for the research. These animals were freely permitted to get access to water and standard chow up to the end of the 15-d experimental phase. The experimental mice were maintained under a 12-h light/dark cycle at a temperature of 23–25 °C and relative humidity of 55–60%.

The mice were randomly allocated into seven groups, with each group consisting of seven mice (n = 7). Initially, all mice underwent depilation of the dorsal region (3 cm x 2.5 cm) using a commercial hair removal cream (Veet). After 24 h, 62.5 mg of imiquimod (IMQ) cream was gently applied on the hairless back of the mice using an applicator for 15 consecutive days. This step was repeated for all groups except for the normal control and vehicle control groups. The experimental design is presented in Table 2.

Scoring Severity of Imiquimod (IMQ) Induced Psoriasis-like Skin Lesions

The intensity of inflammation on the mice's dorsal skin was observed and scored based on the clinical psoriasis area and severity index (PASI) scoring severity of inflammation. Erythema, skin thickness, and desquamation or scaling were evaluated individually on a scale ranging from 0–4: 0 as none, 1 as slight, 2 as moderate, 3 as marked, and 4 as very marked. The aggregate score (comprising erythema, scaling, and thickening scores) was utilized to indicate the severity of psoriasis (scale 0–12) (Sun, Zhao, and Hu 2013). This evaluation method has been approved by experts in the relevant field and has undergone a blind validation process (Flutter and Nestle 2013).

Statistical Analysis

All experiments were conducted in triplicate. Results were expressed as means ± standard error of the mean. For the phytochemical analysis, a T-test was performed using SPSS version 24. The correlation between the TPC, TFC, and antioxidant activity was assessed using Pearson's correlation coefficient (r) with a significance level of $p < 0.05$. For the anti-psoriatic study, two-way ANOVA followed by Tukey's *post hoc* test was employed to determine the significance of differences between groups. *P*-values less than 0.05 were considered statistically significant.

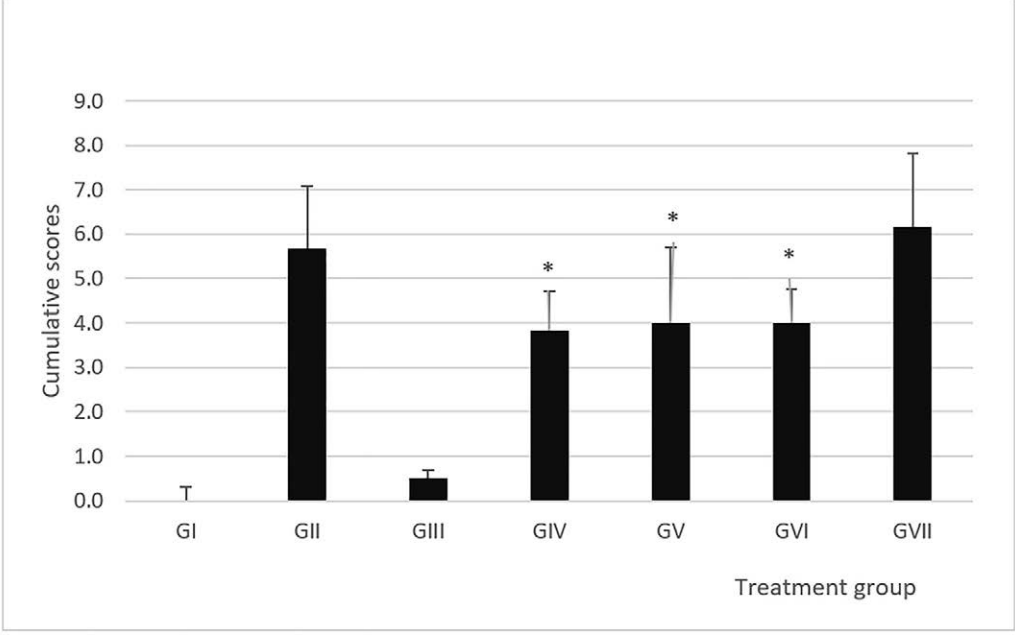

Figure 1. The cumulative score (erythema plus thickness plus scaling scores) (0–12) indicates the psoriasis severity index for different treatment groups at the end of the treatment (Day 15). The results represent mean ± standard error of the mean, SEM. Values were considered significant at $*p < 0.05$. [GI] the normal group; [GII] the negative control, IMQ-treated group; [GIII] the vehicle control cream base-treated group; [GIV] the positive control, IMQ + clobetasol propionate-treated group; [GV] the IMQ + PSPLAE 5%-treated group; [GVI] the IMQ + PSPLAE 10%-treated group; [GVII] the IMQ + PSPLAE 20%-treated group.

Table 2. Summary of animal experimental group.

Group	Name	Description
Group-I	Normal control group	This group was not treated and only tap water was rubbed on the hairless back until the end of the experiment, Day 15.
Group-II	Negative (disease) control group	For 15 consecutive days, this group of mice only received a daily topical dose of 62.5 mg of 5% imiquimod cream on their hairless skin to induce psoriasis.
Group-III	Vehicle control group	This group underwent topical treatment with 62.5 mg of cream base for 15 consecutive days.
Group-IV	Positive control group	The animals in this group were induced with IMQ, similar to those in Group II. On the 8th day, clobetasol propionate cream, which acts as the positive control, was topically applied once daily for the next 8 days.
Group-V	PSPLAE 5% cream group	The mice in this group received topical application of IMQ to induce mouse skin psoriasis, similar to Group II. On the 8th day, 62.5 mg of PSPLAE 5% cream was applied topically for the following 8 days.
Group-VI	PSPLAE 10% cream group	The mice in this group underwent topical application of IMQ to induce mouse skin psoriasis, similar to Group II. On the 8th day, 62.5 mg of PSPLAE 10% cream was applied topically for the subsequent 8 d
Group-VII	PSPLAE 20% cream group	The mice in this group were subjected to topical application of IMQ to induce mouse psoriasis, which was similar to Group II. On the 8th day, 62.5 mg of PSPLAE 20% cream was applied topically for 8 consecutive days.

RESULTS

Extraction Yield of Purple *I. batatas* Leaf Aqueous Extract

Based on the study, the yield of purple sweet potato leaf aqueous extract (PSPLAE) is 17.2 ± 2.33% from three independent experiments.

TPC and TFC of Purple Sweet Potato Leaf Aqueous Extract (PSPLAE)

The equation taken from the standard curve of gallic acid for the estimation of TPC is as follows: y = 0.0038x – 0.0179, r = 0.9997. The TPC of the aqueous extract of *I. batatas* leaf is presented in Table 2. As for the TFC, The equation attained from the standard curve of quercetin for the calculation of TFC is as follows: y = 0.0004x – 0.0278, r = 0.9961. The TFC of *I. batatas* leaf aqueous extract is presented in Table 3.

Antioxidant Assay: DPPH˙ Radical Scavenging Assay

The antioxidant activity of PSPLAE was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. The lowest EC_{50} value indicates the highest activity of antioxidants. Results from the DPPH assay exhibit that PSPLAE showed lower antioxidant activity (EC_{50} = 82.00 ± 8.08 µg/mL) when compared to the standard, BHT (EC_{50} = 60.07 ± 4.18 µg/mL) (Table 4). Based on statistical analysis, PSPLAE was found to be not significantly ($p > 0.05$) different from standard, BHT.

Table 3. Total phenolic (TPC) and total flavonoid (TFC) content of aqueous extract from purple sweet potato leaves.

Sample analyzed	Total polyphenols (mg GAE/g DE)	Total flavonoids (mg QE/g DE)
Purple sweet potato leaf aqueous extract (PSPLAE)	7.62 ± 1.91	2.74 ± 0.85

Table 4. Antioxidant activity of aqueous extract of *I. batatas* leaves and butylated hydroxytoluene (BHT) in DPPH assay.

Sample analyzed	EC_{50} in DPPH radical scavenging assay (µg/mL)
Purple sweet potato leaf aqueous extract (PSPLAE)	82.00 ± 8.08
Butylated hydroxytoluene (BHT)	60.07 ± 4.18

Thus, indicating that the antioxidant activity of PSPLAE is as active and effective as the standard antioxidant, BHT.

Correlation between TPC and TFC with the Antioxidant Activity in PSPLAE

Results from Pearson's coefficient correlation analysis show that both TPC and TFC in PSPLAE have a significant positive ($p < 0.05$) correlation with the antioxidant activities in the DPPH assay (Table 5). Moreover, the association between TFC and antioxidant activity showed a relatively higher correlation coefficient (r) value, indicating that flavonoids might contribute to higher antioxidant activity compared to phenolic content.

Table 5. Linear correlation coefficient (r) between TPC and TFC with antioxidant assay DPPH, of *Ipomoea batatas* leaf extract.

Components	Correlation coefficient (r) value
TPC *vs.* DPPH	r = 0.590, $p < 0.05$
TFC *vs.* DPPH	r = 0.973, $p < 0.05$

Note: Correlation is significant at $p < 0.05$; [TPC] total phenolic contents; [TFC] total flavonoid contents; [DPPH] 2,2-diphenyl-l-picrylhydrazyl

Anti-psoriatic Activity of PSPLAE on Imiquimod (IMQ) Induced Psoriasis-like Dermatitis in BALB/c Mice

The PASI is a quantifiable rating scale that uses area coverage and plaque appearance to measure the severity of psoriatic injuries. Seven days (7 d) after the application of IMQ, indications of erythema, scaling, and thickness were discovered on the dorsal skin of the BALB/c mice (Figure 2). Figure 2 indicates that the topical administrations of PSPLAE cream (both dosages of 5 and 10%) and the standard drug (clobetasol propionate) could lessen the severity of psoriasis in IMQ-induced mice. However, experimental animals in Group 7, which were treated with the highest dose of PSPLAE (10%) showed the most severe skin lesions. For Group 1 (normal control group) and Group 3 (vehicle control group), there were no observable psoriasis-like symptoms on the dorsal skin of BALB/c mice. Meanwhile, for Group 2 – which is the IMQ-treated group – the IMQ was applied for 15 consecutive days. Thus, the psoriasis-like symptoms were clearly observed (Figure 1) and the cumulative score of the PASI scoring was 5.67. Based on the statistical analysis, Group 4 (positive control group), Group 5 (IMQ + 5% PSPLAE), and Group 6 (IMQ + 10% PSPLAE) were found to be significantly different from group 2 (IMQ-treated group). However, experimental animals in Group 7 – which were treated with the highest dose of PSPLAE (20%) – showed the most severe skin lesions and were found not significantly different from Group 2, the IMQ-treated group.

DISCUSSION

In a previous study, the leaves of *Ipomoea batatas* were discovered to have radical scavenging, antimutagenic, anti-cancer, and anti-bacterial properties (Alam 2021). The presence of phenolics and flavonoid content in the leaves of *Ipomoea batatas* L. may contribute to their therapeutic characteristics. Based on the findings, when phenolics are detected in the extracts, the color of the Folin-Ciocalteau reagent changes from yellow to blue, which is caused by the chemical reduction of the mixture of tungsten and molybdenum oxides in the reagent. Due to the higher solubility of gallic acid in methanol than in water or other solvents (such as ethanol), methanol was employed to dilute the gallic acid standard in this study (Park and Lee 2024). According to Alam (2021), the total phenolics content in different types of *I. batatas* leaves ranged from 1.42–17.1 g/ 100 g dry weight in previous research. In addition, geographical considerations – as well as varied growth practices – could explain the variation in total phenolic levels (Alam 2021).

Flavonoids have a diverse variety of biological and pharmacological effects. These can act as reducing agents, singlet oxygen quenchers, metal chelators, reactive oxygen species (ROS) scavengers, and chain-breaking antioxidants (Naseer *et al*. 2014). These flavonoids have inhibitory properties against the bacteria that cause plant diseases. Other than that, flavonoids' structure is thought to play a part in the extract's oxidative capabilities (Hue *et al*. 2012). Green leafy vegetables are known to have significant antioxidant activity, which is recognized in part due to the existence of flavonoids in these plants. Thus, phenolic, and flavonoid content is important due to its role in scavenging free radicals in the human body and to aid in the maintenance of a healthy body by scavenging or eliminating ROS.

The antioxidant activity of PSPLAE was compared with the antioxidant activity in standard, BHT compounds by using DPPH radical scavenging assay. BHT prevents unsaturated organic molecules from oxidizing. BHT is used in foods, cosmetics, and industrial fluids due to its function to inhibit oxidation and the production of free radicals. EC_{50} is utilized to convey the level of effective concentration of extracts that enables to scavenging of 50% of the free radicals. Moreover, the lowest EC_{50} value indicates the highest activity of antioxidants. From this study, the activity of antioxidants in purple sweet potato leaf was discovered to be not significantly ($p > 0.05$) different from the standard BHT which indicates that the antioxidant activity of PSPLAE and BHT have the same strength and effectiveness. Moreover, there is also a positive association between the TPC and TFC with the antioxidant activity of the aqueous purple sweet potato leaf. This indicates that the antioxidant activity of PSPLAE was contributed by the total phenolic and TFC.

Due to the demand for a more safe and effective treatment of psoriasis, a less costly method – which is traditional medicine research – has been generated. Purple sweet potato leaf was used by ancient people to treat wounds and other inflammatory diseases. But, due to the lack of scientific research and evidence, a new study that involves purple sweet potato leaf has been done to see its anti-psoriatic effect on IMQ-induced psoriasis-like dermatitis. IMQ is a toll-like receptor-7/8 (TLR7/8) agonist that has been authorized to manage keratosis, external genital

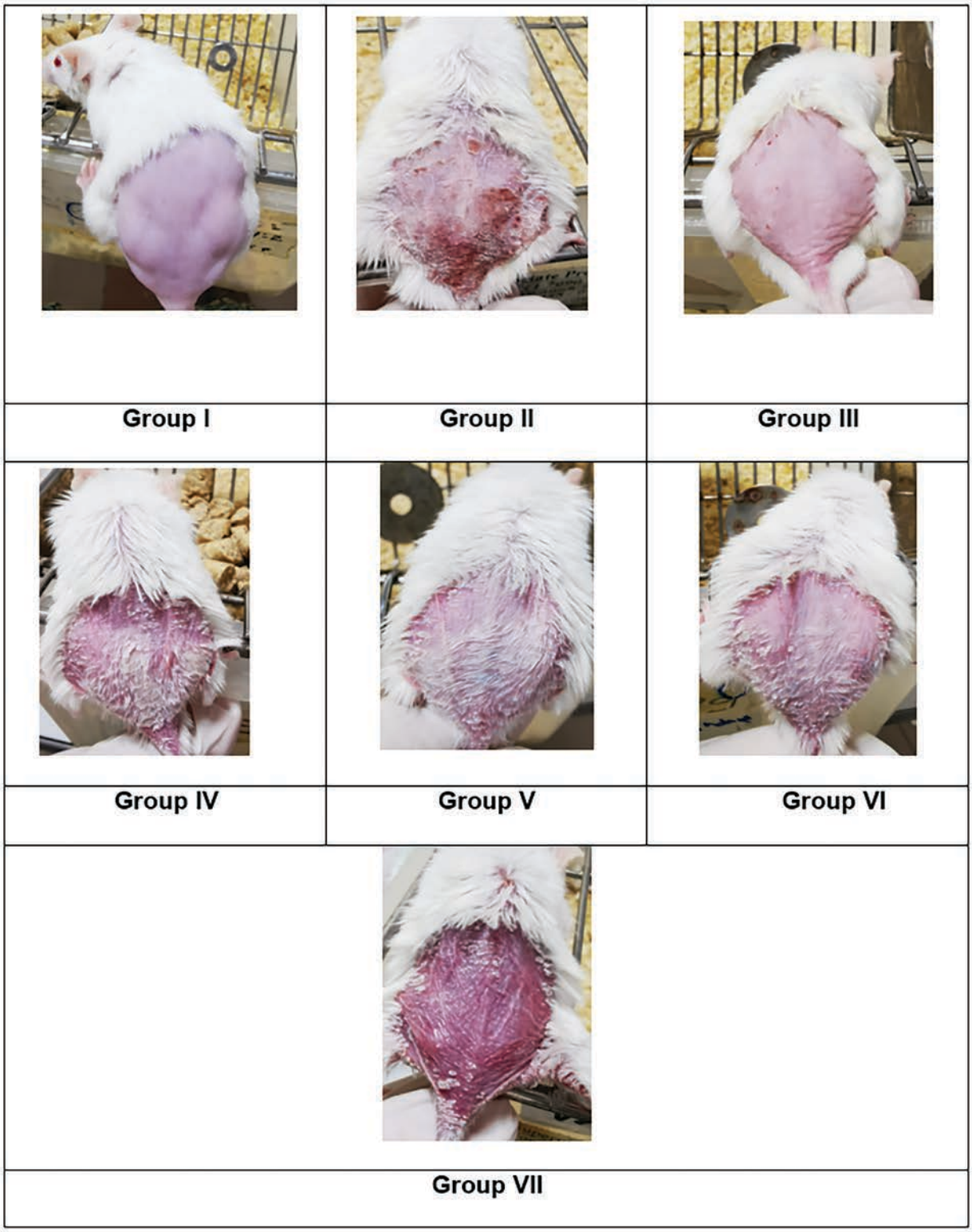

Figure 2. IMQ-induced psoriasis-like dermatitis on the backs of BALB/c mice. The back skin of the three groups exhibited different grades of erythema, scales, and infiltration. Photos were taken on Day 15. [GI] the normal group; [GII] the negative control, IMQ-treated group; [GIII] the vehicle control, cream base-treated group; [GIV] the positive control, IMQ + clobetasol propionate-treated group; [GV] the IMQ + PSPLAE 5%-treated group; [GVI] the IMQ + PSPLAE 10%-treated group; [GVII] the IMQ + PSPLAE 20%-treated group.

warts, and superficial basal cell carcinoma (Flutter and Nestle 2013). Psoriasis-like dermatitis was observed on the hairless back of the mice after 7 d of IMQ application. The findings also show that the PASI scoring was elevated in Group 2, the IMQ-induced group (Figure 1). Other than that, with the application of 5 and 10% of PSPLAE cream, the cumulative score of PASI scoring shows a decrease in skin thickening, erythema, and scaling. This indicates that the usage of PSPLAE up to 10% could lessen the severity of the skin lesions in IMQ-induced psoriasis-like skin lesions in BALB/c mice. However, the usage of 20% of PSPLAE which is the highest dose, shows no observable changes in the severity of the psoriasis-like skin lesion in mice. This indicates that the topical administration of 20% of PSPLAE cream was not able to reduce the IMQ-induced psoriasis-like dermatitis in BALB/c mice. This is because the concentration of the PSPLAE is too high and becomes toxic to the mice. Studies have shown that high concentrations of certain active compounds in topical formulations can lead to skin irritation and toxicity. For instance, a study on the topical application of high-dose corticosteroids demonstrated increased incidences of skin atrophy, striae, and contact dermatitis, indicating that higher doses can indeed induce adverse effects (Lin *et al*. 2015). PSPLAE indicates that lower concentrations (5 and 10%) are generally well-tolerated, higher concentrations (20% and above) may lead to increased local skin reactions, including erythema and desquamation. These reactions can mask or interfere with the therapeutic effects of the treatment, leading to a lack of improvement or even worsening of PASI scores (Lin *et al*. 2015).

One of the limitations of this study is that inflammation may occur in the skin, apart from the triggered area. However, to ensure no other inflammation, we closely monitored the mice and observed that none of them exhibited any signs of infection outside of the triggered area on their skin. Our study demonstrated that skin infection was effectively contained within the triggered area of the mouse skin, with no signs of infection observed elsewhere.

CONCLUSION

In conclusion, the purple sweet potato leaf can aqueous extract has shown the presence of total phenolic, total flavonoid, and the ability to scavenge free radicals. There is a definite correlation between antioxidant substances (TPC and TFC) and antioxidant activity (DPPH assay) in the aqueous extract of purple sweet potato leaf. The dosages of 5 and 10% of PSPLAE cream were able to decrease the seriousness of psoriasis in IMQ-induced mice. Thus, the purple sweet potato leaf is a good and affordable source of organic antioxidants and can be developed as an anti-psoriatic agent to reduce the symptoms of psoriasis. However, further research on the efficacy and safety of PSPLAE extracts as topical psoriasis treatment is required. To understand the mechanism of PSPLAE activity in IMQ-induced psoriasis-like skin lesions in BALB/c mice, further molecular research is required.

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STATEMENT ON CONFLICT OF INTEREST

The authors declare no competing interest regarding the publication of this manuscript.

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