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Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Madame HONG Jingyang,

Titulaire d'un *master of agriculture,*

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 23 mai 2022, à 9h00 précises (personne ne sera admis après cette heure),

en l'auditorium G (Bât. 9),

Passage des Déportés, 2, à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Study on the valorization of sweet potato leaf polyphenols as skin photoprotectors ».

Le jury est composé comme suit :

Présidente : Prof. M.-L. FAUCONNIER, Professeure ordinaire,
Membres : Prof. A. RICHEL (Promotrice), Prof. C. BLECKER (Copromoteur), Prof. T. MU (Copromoteur - CAAS, Chine), Prof. E. HAUBRUGE, Dr N. JACQUET, Dr P. MALUMBA KAMBA, Prof. H. SUN (CAAS, Chine).

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Summary

Nowadays, plant polyphenols are more and more targeted as anti-UV candidates to substitute physical and chemical UV absorbers. So, research on the new sources of polyphenols, development of separation and purification methods, and assessment on anti-ultraviolet activity of these natural compounds have attracted more attention and become necessary. Sweet potato (*Impoea batatas L.*) is the fifth-largest food crop in the world. Sweet potato leaves are the main by-products of sweet potato production. They are rich in polyphenols, including 70% phenolic acid and 10-20% flavonoids. In this thesis, the valorization potential of sweet potato polyphenols for photoprotective effects on skin was evaluated. First of all, leaves from 13 sweet potato cultivars were collected as raw materials. The nutritional composition, antioxidant activity, and sun-screen activity of different sweet potato leaf samples was determined, and the comprehensive nutritional quality was calculated by Grey Relational Analysis. Results showed that the nutritional and functional components are significantly different between cultivars. Tainong71 cultivar showed the highest comprehensive nutritional quality, followed by Fu22, Ningcai, Fu23, Ecai10, Zhecai726, Ecai1, Fu18, Pushu53, Guangcai5, Shulv1, Guangcai2, and Zhecai1. The antioxidant activity varied from 3.94 to 16.75 g Trolox equivalent/100 g dry weight. Pushu53 showed the highest sunscreen activity, with a sun protection factor of 24.65. There was a positive correlation between antioxidant activity and sunscreen activity ($r = 0.737$, $p = 0.004$). In conclusion, sweet potato leaves possess high nutritional and functional properties and have the huge potential to be used as green leafy vegetables and sunscreen agents. Second, membrane technology was considered to concentrate phenolic compounds. The aim was to establish an efficient and environmentally friendly separation method. Microfiltration with 0.45 μm, ultrafiltration (UF) with molecular weight cut-off (MWCO) of 10,000 Da, and nanofiltrations with MWCO of 200-300 (NF1), 400-600 (NF2), and 800-1,000 Da (NF3) were adopted. LC-MS/MS and HPLC were used to profile the polyphenols from sweet potato leaves (SPLP). The fraction with the highest polyphenol concentration and sunscreen activity was screened out. The results showed that the soliution of SPLP by NF1 was the highest (98.73%). The concentrated solution by NF2 (fraction 7) possessed the highest polyphenol concentration (837.5 μg CHA/mL) and the best sun protection factor (10.37). Ten individual phenolic compounds were identified from fraction 7, including 8 phenolic acids and 2 flavonoids. Therefore, membrane separation is an effective way to obtain high active polyphenols, which might be an inestimable prospect in the food, pharmaceutical, and cosmetic industry. Thirdly, the BALB/C nude female mice were adopted for animal experiments. The moisture, hydroxyproline (HYP) content of mice skin were determined. The thickness of the epidermis and dermis were investigated. Histological evaluation was conducted by hematoxylin-eosin and Masson stain. The superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px) activities， malondialdehyde (MDA), and protein carbonyl content were assessed. Expression of matrix metalloproteinase-1 (MMP-1), tumor necrosis factor-alpha (TNF-α), nuclear factor-κappa B (NF-κB) were determined. The mitogen-activated protein kinase (MAPK) signaling pathways including JNK, ERK, and p38 were assayed by Western Blotting. Results showed that SPLP and caffeic acid inhibited the UV-induced decrease in skin moisture and HYP content and reduced both epidermal and dermal thickening. Oral and topical application of SPLP, or caffeic acid ameliorated the UV-induced reduction in activity of the antioxidant enzymes CAT, SOD, and GSH-Px, the increases in MDA content and protein carbonyls, and the UV-induced increase in production of the pro-inflammatory mediators MMP-1, TNF-α, and NF-κB. Topical application of SPLP or caffeic acid, both before and after UV irradiation, ameliorated the increased phosphorylation of the stress-signaling proteins JNK and p38. These effects were dose-dependent and taken together, indicate that SPLP has a strong, multi-target anti-inflammatory effect on UV-induced skin damage.