摘要

本研究分成兩部分，第一部分為探討金針花苞不同生長階段和熱加工處理對其總類胡蘿蔔素(total carotenoids；TC)含量、總酚化合物（total phenolic compounds；TPC）含量及抗氧化活性之影響。首先將金針花苞依其生長期分為一至四階段其平均長度分別為 3、6、8 與 10 cm，結果顯示隨著平均長度增加其全反式玉米黃質含量漸增，而全反式葉黃素則漸減。其次探討花苞萃取物於皂化前後對其 TPC 與抗氧化活性的影響；其中以第四階段未皂化花苞萃取物的 TPC 與抗氧化能力最佳，其 Trolox 當量抗氧化能力(TEAC)和抑制脂質過氧化物(IP%)生成能力分別可達 21436 μg Trolox/ g dry weight 和 62.95%。第四階段金針花苞經水煮 1~20min 其 TC 含量並沒有顯著差異，但經油炒 1min 則顯著地下降 44.01%；結果也指出 TEAC 與 TPC 均隨著水煮時間增加而顯著減少，但油炒 1 min 則均無顯著差異；在 IP %方面，唯有水煮 20 min 與對照組比較有顯著降低外，其他熱加工處理則無顯著差異；螯合亞鐵離子能力則是以水煮 5 min 及油炒 1min 與對照組比較有顯著增加。由以上結果顯示經適當程度的水煮，可有效保留蔬菜之 TC 與 TPC，進而維持其抗氧化性，但過度水煮，由於 TC 與 TPC 被破壞反而降低其抗氧化活性。

第二部份則是以番薯葉為萃取原料，探討類胡蘿蔔素部分純化之最佳條件。結果指出凍乾番薯葉於 TC 萃出量及操作性較新鮮的為佳，而四氫呋喃為其最佳萃取溶劑。四氫呋喃萃取物經管柱分離時，以氧化鋁為管柱充填吸附劑，並以不同濃度的正己烷與丙酮做為沖提液，採梯度沖提方式進行葉黃素與β-胡蘿蔔素之部分純化，以分光光度計及 HPLC 分析發現，β-胡蘿蔔素在正己烷：丙酮＝9：1 時被沖提出來，而葉黃素及玉米黃質在正己烷：丙酮＝1：1 時會被同時沖提出來。接著將所得區分物進行葉黃素類的酯鏈辨別，發現

番薯葉中主要是以游離態葉黃素為主。安全試驗結果顯示全反式葉黃素和β-類胡蘿蔔素其用量分別於 7.5ppm 和 15ppm 以下對細胞並不會造成傷害，在衛生署規定之安全攝取量下並無安全的疑慮。最後經過一個月的保存安定性實驗發現，在低溫 4℃、避光且充填氮氣的條件下，其保存的效果最佳。

關鍵字：類胡蘿蔔素、葉黃素、玉米黃質、β-胡蘿蔔素、熱加工、抗氧化活性、金針花苞、番薯葉、細胞存活試驗、儲藏安定性評估

Abstract

There were two aims of this research. One of them was to study the effects of different maturation stages and thermal processing of daylily buds on the content of total carotenoids (TC) and total phenolic compounds (TPC) as well as antioxidant activity. According to the average length of 3、6、8 and 10 cm, daylily buds were divided into four maturation stages. The results showed that the all-trans zeaxanthin content increased but all-trans lutein decreased as the length of the buds increased. The effect of saponification or unsaponification of ethanol extracts from four maturation stages of daylily buds on total phenolic compounds (TPC) and antioxidant activity were investigated. Results showed that the unsaponification of the extract from the 4^{th} maturation stages had the highest TPC and antioxidant activity. Its trolox equivalent antioxidant capacity (TEAC) and inhibition of peroxidation (IP%) were 21436 μg Trolox/ g dry weight and 62.95% , respectively. Therefore, daylily buds at the 4^{th} maturation stage were employed to evaluate the effect of thermal processing on TC、TPC and antioxidant activity. It was found that there was no significantly TC loss for 1-20 min boiling water cooking, but stir-fried for 1 min resulted in 44.01% loss as compared with control group. It was also found that TPC decreased as the boiling time increased. Both TEAC and TPC decreased significantly as the boiling time increased, but stir-fried for 1min was no significant loss. There was no significant IP% loss during boiling and stir-fried, except for boiling for 20min. Chelating effects on ferrous ions significantly increased by boiling for 5min and stir-fried for 1min. These result showed that suitable boiling treatment increased the carotenoids content, TPC and antioxidant activity, but over boiling treatment decreased them.

Another aim was to study partial purification of carotenoids using open column chromatography from the extract of sweet potato leaves. Base on the

operation and extraction efficiency of carotenoids, freeze-dried sweet potato leaves as the experimental material was better than fresh one. Tetrahydrofuran was selected as the best solvent for carotenoids extraction. For partial purification of carotenoids, open column chromatography with aluminum as adsorbent was employed. To compare the separation efficiency of carotenoids, various ratios of hexane and acetone as the running buffer in gradient elution system were applied to separate and purify β-carotene from xanthophylls. The results indicated that the ratio of hexane/acetone with 90/10 was developed to separate β-carotene and with 50/50 was used to obtain xanthophylls. It was found that the major form of xanthophylls was free form in sweet potato leaves. According to cell viability assay, the dosage of all-trans lutein and β-carotene under 7.5ppm and 15ppm, respectively were non-toxic for 3T3-L1 preadipocytes. Finally, the best storage conditions for carotenoids were under 4 ℃, dark and filled with nitrogen during storage test for a month.

Keywords: carotenoids; lutein; zeaxanthin; β-carotene; thermal processing; antioxidant activity; daylily buds; sweet potato leaf; cell viability assay; storage test