高劑量β-胡蘿蔔素，canthaxanthin 和維生素 E 在高大豆油攝取下對大白鼠體內對抗氧化酵素及脂質代謝的影響

Activities of Antioxidant Enzymes and Lipid Metabolism in Rats Fed High Dose ofβ-Carotene, Canthaxanthin and Vitamin E in High Fat and Cholesterol Diets

中文摘要

心血管疾病和癌症一直是西方國家常見疾病，且其具有高死亡率，癌症、腦血管疾病和心血管疾病同時也是我國十大死因之第一、第二及第四位。而流行病學調查發現新鮮蔬菜水果的攝取量和心血管疾病及癌症的發生率呈負相關，血中抗氧化劑濃度低時，罹患心血管疾病的危險性增加，低密度脂蛋白過氧化情形也較嚴重。類胡蘿蔔素和維生素 E 在蔬菜水果中含量很高，本研究主要以β-胡蘿蔔素、乳化型β-胡蘿蔔素、乳化型 canthaxanthin 和維生素 E 當材料，進行研究。

本研究目的係在探討高油脂及高膽固醇的餵食條件下，高劑量β-胡蘿蔔素、canthaxanthin 和維生素 E 對大白鼠體內脂質代謝及抗氧化狀況的影響。實驗一：將 72 隻 Wistar 品系大白鼠（ 體重約 252 g）隨機分成 6 組，採用 AIN－76 標準飼料配方，每組飼料中油脂含量均爲 15% ，各組分別餵予不添加膽固醇和膽酸；添加 1% 膽固醇和 0.1% 膽酸；添加 1% 膽固醇和 0.1% 膽酸再分別添加 0.2% β-胡蘿蔔素、乳化型β-胡蘿蔔素、乳化型 canthaxanthin 和維生素 E。實驗進行六週後，分析血漿和肝臟中β-胡蘿蔔素、視網醇、canthaxanthin 及維生素 E 濃度，分析紅血球及肝臟中抗氧化酵素包括 catalase、superoxide dismutase (SOD)、glutathione peroxidase (GSH Px) ，及 glutathione reductase (GSH Rd) glucose-6-phosphate dehydrogenase (G-6-PDH)的活性，並分析血漿及肝臟中過氧化指標產物 malondialdehyde (MDA) ，及肝臟中 conjugated diene 含量。

實驗二：將 84 隻 Wistar 品系雄性大白鼠（ 體重約 250 g）隨機分成 6 組，實驗設計如同實驗一，實驗進行六週後，作肝組織切片、血漿及肝臟中總膽固醇 (TC)及三酸甘油酯（TG）濃度，並利用超高速離心法將血漿中極低密度脂蛋白 (VLDL)、低密度脂蛋白（LDL）、高密度脂蛋白（HDL)分離，分別分析其膽固醇及三酸甘油酯濃度，此外並分析糞便中總中性固醇及總膽酸含量。

實驗一之結果顯示：血漿中β-胡蘿蔔素含量在給予乳化型β-胡蘿蔔素組較高，顯示乳化型β-胡蘿蔔素的吸收率較β-胡蘿蔔素高。在視網醇方面，血漿視網醇並不隨著β-胡蘿蔔素的補充而一直上升，肝臟視網醇濃度均爲給予β-胡蘿蔔素組高於未給予β-胡蘿蔔素組，而膽固醇的給予，會使視網醇下降。SOD 及 GSH Px 的活性均會因爲膽固醇的給予而降低，但所添加的抗氧化劑β-胡蘿蔔素、canthaxanthin 和維生素 E 均能明顯提升其活性。在 thiobarbituric acid (TBA)實驗中，膽固醇的添加會提升血清及肝臟中 MDA 量，及肝臟中 conjugated diene 量，

血清中 MDA 含量以維生素 E 組較低，肝臟中則因爲抗氧化劑的補充，都能顯著的降低，維生素 E 也能明顯的降低肝臟中 conjugated diene。
在實驗二的肝臟組織切片中，膽固醇的給予造成輕微的發炎現象，而β-胡蘿蔔素的給予對於細胞有較好的影響，canthaxanthin 和維生素 E 的給予則使脂肪肝現象更爲嚴重。給予膽固醇後，會明顯提升血清中之總膽固醇濃度，降低了 HDL 膽固醇，canthaxanthin 和維生素 E 對膽固醇沒有影響，β-胡蘿蔔素則能顯著的降低血清中膽固醇及 LDL 膽固醇，canthaxanthin 和維生素 E 均會提升肝臟中總膽固醇含量。β-胡蘿蔔素會提升血清三酸甘油酯，維生素 E 則可明顯降低血清中三酸甘油酯，canthaxanthin 和維生素 E 均會提升肝臟中總三酸甘油酯含量，其中以維生素 E 之影響最明顯。而β-胡蘿蔔素可以增加糞便中性固醇和總膽酸。
總結: β-胡蘿蔔素、canthaxanthin 和維生素 E 都可以降低因添加膽固醇所提升的氧化壓力，以及能夠提升紅血球中 GSH Px 及肝臟中 SOD 的活性。β-胡蘿蔔素降低血漿中總膽固醇及低密度脂蛋白膽固醇濃度，並且能夠增加糞便中固醇及總膽酸。

英文摘要

The purpose of this study was to investigate the effect of high dose β-carotene, canthaxanthin vitamin E on the activities of antioxidant enzymes and lipid metabolism in rats fed high fat and cholesterol diet. Experiment I: Seventy-two male Wistar rats (weight about 252 g each) were randomly divided into six group : two control groups with or without adding 1 % cholesterol and 0.1 % cholic acid , the other groups fed 0.2 % β-carotene, beadlet β-carotene, canthaxanthin or vitamin E with 1 % cholesterol and 0.1 % cholic acid, all groups contained 15 % soybean oil. The rats of each group were sacrificed at the end of six-week feeding period, then the artery blood, liver and feces were collected. The levels of β-carotene, canthaxanthin, retinol andα-tocopherol were analyzed by HPLC. Analytical items included the activities of catalase, superoxide dismutase (SOD), glutathione peroxidase (GSH Px), glutathione reductase (GSH Rd), Glucose-6-phosphate dehydrogenase (G-6-PD), plasma and liver total cholesterol (TC), triglyceride (TG), thiobarbituric acid reactive substance (TBARS) test and liver conjugated diene. Experiment II: Eighty-four male Wistar rats (weight about 250 g each) were randomly divided into six groups. Experimental design was the same as experiment I. Analytical items included pathological histology of liver tissue, plasma and liver total cholesterol (TC) and triglyceride (TG), plasma cholesterol and triglyceride level of very low density lipoprotein (VLDL), low density lipoprotein (LDL), high density lipoprotein (HDL), feces neutral steroids and total bile acids.
In experiment I, the result showed that plasma β-carotene concentrations were higher in rats fed beadlet β-carotene, indicating that beadlet β-carotene had higher absorption

than normal β-carotene. Rats fed cholesterol resulted in low plasma and liver retinol had lower concentrations, whereas β-carotene feeding resulted in higher plasma and liver retinol concentrations than the other groups fed cholesterol diets.
The activities of SOD and GSH Px were decreased by feeding cholesterol diet,while β-carotene, canthaxanthin and vitamin E could increase those enzyme activities ($P<0.05$). The cholesterol diets would increase liver TBARS, conjugated diene, plasma TBARS, and these items were decreased by feeding antioxidants. Experiment II : Rats fed cholesterol diets groups were induced series fatty liver, and rats fed β-carotene diets were better cross to normal. Rats had cholesterol-feeding group had higher plasma total cholesterol and LDL-C concentrations. Fed β-carotene diets result in plasma total cholesterol and LDL-C decreased significantly ($P<0.05$).
Canthaxanthin and vitamin E fed groups had higher triglyceride
in liver. The feces neutral steroids and bile acids were increased in rats fed β-carotene.
In conclusion, β-carotene, Canthaxanthin and vitamin E could decreasethe oxidative stress from dietary cholesterol. The activities of SOD and GSH Px were decreased in rats fed cholesterol diet and β-carotene, canthaxanthin and vitamin E could increase those activities. β-carotene-fed decreased plasma total cholesterol and LDL-C. And β-carotene increasedthe feces neutral steroids and total bile acids.