國產基隆山藥酸酪乳之抗氧化性及其對餵食高脂飼料SD大白鼠脂質代謝之影響

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摘 要

本實驗將具有保健功效的基隆山藥，以ABLS菌接種發酵製成深受歐美消費者喜愛的酸酪乳，除增加其產品的機能性外，也以雄性Sprague-Dawley(SD)大鼠誘發高血脂的模式，來探討服食山藥酸酪乳的實驗組老鼠在高油飲食條件下對血液中三酸甘油酯的形成之改善情形。第一階段(Phase I)的動物實驗主要先探討服食山藥酸酪乳及將酸酪乳微奈米化後對六週齡的年輕大鼠之血脂形成的改善效果，四個處理組各分為: (A)誘發高油脂組(Control)-未服食任何酸酪乳、(B)純酸酪乳(Yogurt)、(C)山藥酸酪乳(Yam Yogurt)、(D)奈米山藥酸酪乳(Nano Yam Yogurt)；餵食六週期間餵食採自由飲水和攝食的方式，每週固定抽尾靜脈血，在離心取上清液(血清)1.0毫升，進行GOT（Glutamic Oxaloacetic Transaminase 麩氨基酸草醋酸轉氨基酵素）、GPT（Glutamic Pyruvic Transaminase 麩氨基酸焦葡萄轉氨基酵素）、CRE (Creatinine 肌酐酸)、CHO (Cholesterol 膽固醇)、TG (Triglyceride 三酸甘油脂)、HDL (High-density lipoprotein 高密度脂蛋白)、LDL (Low-density lipoprotein 低密度脂蛋白)等七個項目的測定。實驗結果顯示，餵食山藥酸酪乳可明顯降低實驗組大鼠血液中LDL的含量並提高HDL的含量，同時CRE、GOT和GPT測值也有明顯降低；(C)組的膽固醇比(D)組還低，顯示將酸酪乳奈米化似乎對血脂的改善並無額外加成的效果；雖然(B)和(C)兩組大鼠的體重較其他處理組有明顯降低，但各處理組間的組織臟器重量則並沒觀察到有顯著的差異。實驗的SD大鼠在完成第一階段的動物實驗後，以正常飲食餵食一年(五十四週)後，進行第二階段實驗(Phase II)探討高齡化SD大白鼠對高油脂食物的敏感度及再餵食酸酪乳及山藥酸酪乳對實驗大鼠血脂形成改善的效果。實驗結果顯示餵食山藥酸酪乳的大鼠其膽固醇和三酸甘油脂增加的速度都明顯的低於其他處理組，同時其GPT與CRE值都是(A)、(B)、(C)三組裏的最低者。另外一個值得觀察的現象是在高齡化大鼠的抗疲勞實驗結果明顯的看出有餵食純酸酪乳與山藥酸酪乳的(B)和(C)老鼠有更佳的耐力，比餵食高油脂的控制組更能夠延緩疲勞的時間多達80%。經過兩週儲藏的酸酪乳，酸鹼值保持在4.8-4.2中，並無明顯變化。山藥酸酪乳的乳酸菌數可測得達十億隻以上菌落，且抗氧化實驗也證實其具有良好的清除自由基的活性，以及螯合亞鐵離子的能力。綜合以上結論，推測本實驗中大鼠食用山藥酸酪乳可能可以改善因高脂飲食所造成之膽固醇和三酸甘油脂的堆積，也可能具有提昇血中HDL和降低LDL的含量與抗疲勞功用，同時也不會造成人體肝、腎的負擔。建議國人從小開始養成服食山藥酸凝乳的習慣，並在成年後繼續服用，以改善國人在心血管疾病的日益嚴重的問題。

關鍵詞 : 基隆山藥、酸酪乳、降血脂、抗疲勞、抗氧化、SD大白鼠

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參考文獻

1.行政院衛生署。健康食品之抗疲勞功能評估方法。衛署食字第０九二０四０一六二九號。 2.邱雪惠。2000。植物來源乳酸菌之特性評估及抑制沙門氏菌於腸道侵入性與激活巨噬細胞之能力分析。國立中興大學食品科學系碩士學位論文。台中。 3.吳麗容。2001。台灣與日本產山藥的生食與熟食對小白鼠胃腸道功能及抗氧化作用的影響。中山醫學院營養科學學位論文。台中。 4.林坤山。1999。根莖類澱粉顆粒對 α-amylase 感受性之探討。靜宜大學食品營養學系碩士學位論文。台中。 5.紀如珍。2000。滾筒乾燥山藥粉末的復水與加工應用特性。國立台灣大學食品科技研究所碩士學位論文。台北。 6.高馥君、李敏雄。1998。食品保存與抗氧化劑。食品工業月刊。30(12):17-24。 7.陳忻長。2000。加熱與乾燥對基隆山藥之機能性影響-對大白鼠糖代謝及脂質代謝的影響。國立海洋大學食品科學系碩士學位論文。基隆。 8.陳冠福。2002。利用山藥與Lactobacillus plantarum CCRC 10069 及 12250發酵之優酪乳對高油脂飲食的大白鼠脂質代謝與腸道生的影響。國立海洋大學食品科學系碩士學位論文。基隆。 9.陳振揚。1993。化工機械。第157-162頁。三民書局。台北，台灣。 10.陳詩詩。2001。以免疫調節及細胞再生觀點探討山藥生物活性之研究，國立陽明大學生物藥學研究所碩士論文。台北。 11.陳惠英、顏國欽。1998。自由基、抗氧化防預與人體健康。中華民國營養學會雜誌。23(1): 105-121。 12.陳惠添。2004。龍根菌於不同培眼基中生長和對酸與膽鹼之耐受性及其抗氧化活性。國立中興大學食品科學系碩士論文。台中。 13.黃淑娟。2002。奈米粉體製程技術。第14-38頁。化工資訊16(4)。台北，台灣。 14.黃增泉。1993。植物分類學: 台灣維管束植物科誌。南天出版社。台北，台灣。 15.黃鵬、蔡淳瑩。1995。不同種植時期對長形山藥生育與產量之影響。花蓮區農業改良場研究彙報。11: 13-22。 16.曾慶瀛、余哲仁、劉新裕。1994。粉末山藥之製備及其貯藏期間品質變化之研究。中華生質能源學會會誌。13: 92-101。 17.楊健生。1978。化工機械。第292-319頁。大中國圖書公司。台北，台灣。 18.潘書毓。台灣產山藥之酚類含量及抗氧化特性與加工的影響。中國文化大學生活應用科學研究所。2003。台北。 19.劉新裕、王昭月、徐原田、宋麗梅。1995。本省山藥之研究。中醫藥雜誌。6: 111-126。 20.劉新裕、張同吳、林義恭、王昭月。2000。優良保健植物山藥之開發與利用。行政院農業委員會農業試驗所編印。台中。 21.劉新裕、張同吳、林義恭、陳淑芬、王昭月、朱戩良、王順成。1999。山藥之品種特性、生產潛力、物化性質與抗氧化研究。中華農業研究。48(4): 1-22。 22.劉俊岳。2010。山藥酸酪乳的抗氧化能力及機能性成分之研究。大葉大學生物產業科技學系碩士學位論文。彰化。 23.劉凱崴。2002。山藥酸乳酪之發酵技術與抗氧化性及抗致突變性之探討。國立臺灣海洋大學食品科學系碩士學位論文。基隆。 24.賴滋漢、金安兒、柯文慶。1993。食品加工學。精華出版社。台中，台灣。 25.廖啟成。1998。乳酸菌之分類及應用。食品工業月刊。30: 1-10。 26.廖啟成、邱雪惠、楊媛絢。2001。乳酸菌及雙歧桿菌製品介紹與國內研究現況。機能性醱酵製品研討會。2001 年9月5日，台北。 27.盧崇如。2003。基隆山藥區分物對大白鼠血糖與血脂之影響，國立台灣大學食品科技研究所碩士論文。台北。 28.聶桂華、周可范、董秀華、張村，1993，山藥的研究概況，中草藥，24: 158-160。 29.龔財立、姜金龍、劉新裕、黃鵬。1995。台灣農家要覽農作篇(一)。山藥。pp. 175-182。豐年社。台北。 30.Abbas, A. K., A. H. Lichtman, and J. S. Pober. 1997. Cellular andMolecular Immunology. Third edition. W. B. Saunder, Esition. 31.Ames, B. N., M. K. Shigenaga, and T. M. Hagen. 1993. Oxidants,antioxidants, and the degenerative diseases of aging. Proc.Natl. Acad .USA 90: 7915-7922. 32.Annika, M. M., Manninen, M. and Gylienbery, H. 1983 The adherence of lactic acid bacteria to the columnar epithelial cells of pigs and calves. J. Appl. Bacteriol. 55 : 241-245. 33.Araghiniknam, M., S. Chung, T. Nelson-White, C. Eskelson, and R. R.Watson. 1996. Antioxidant activity of dioscorea and dehydroephiandrosterone (DHEA) in older humans. Life Sci. 59(11):147-157. 34.Bedford TG, Tipton CM, Wilson NC, Oppliger RA and Gisolfi CV .1979.Maximum oxygen consumption of rats and its changes with various experimental procedures. J Appl Physiol 47: 1278-1283. 35.Bjorck, I., A. C. Eliasson, A. Drews, M. Gudmundsson, and R. Karlesson. 1990. Some nutritional properties of starch and dietary fiber in barley genotypes containing different levels of amylase Cereal Chemistry 67: 327. 36.Chance, B., H. Sies, and A. Boveris. 1979. Hydroperoxide metabolism in mammalian organs. Physiol. Rev. 59: 527-605. 37.Chen, Y. and Wu, Y. 1994. Progress in research and manufacturing of steroidal sapogenins in China. Journal of Herbs, Spices & MedicinalPlants. 2: 59-70. 38.Coconnier, M. H., V. Lievin, M. F. B. Camard, S. Hudalt, and A. L.Servin. 1997. Antibacterial effect of the adhering human Lactobacillus acidophilus strain LB. Antimicrobial. Agents and chemotherapy 5: 1046-1052. 39.Lactobacillus acidophilus strain LB. Antimicrobial. Agents andchemotherapy 5: 1046-1052. 40.Daly, C. 1991. Lactic acid bacteria and milk fermentations. Journal of Chemical Technology and Biotechnology 51: 544-548. 41.De Deckere, E. A. M., Kloots, W. J. and Van Amelsvoort J. M. M. 1993. Resistant starch decreases serum total cholesterol and triacylglycerol concentration in rats. American Institute of Nutrition 7:2142-2151. 42.Dinis,T.C.P.,Moadeira,V.M.C and Almeida,L.M.1994.Action of phenolic derivatives(acetaminophen,salicylate,5-aminosalicylate)as nhibitord of membrane lipid peroxidation and as peroxyl radical seavengers.Arch. Biochem.Biophys.315:161-169. 43.Drapeau, D., Sauvaire, Y., Blanch, H. W. and Wilke, C. R. 1986.Improvement of diosgenin yield form Dioscorea deltoidea plant cell cultures by use of a non- traditional hydrolysis method. Planta Medica.32: 474-478. 44.Draper, H. H., S. Agarwal, D. E. V. Nelson, J. J. Wee, A. K. Ghoshal, and E. Farber. 1995. Effects of peroxidative stress and age on the concentration of a deoxyguanosine-malondialdehyde adduct in rat DNA.Lipids 30(10): 959-961. 45.Dodds, K. L., and D. L. Collins-Thompson. 1984. Nitrite tolerance and nitrite reduction in lactic acid bacteria associated with cured meat products. Food Microbiology 1: 197-204. 46.Englyst, H. N., and G. T. MacFarlane. 1986. Breakdown of resistant starch and readily digestible starch by human gut bacteria. Journal of the Science of Food and

Agriculture 37: 699-704. 47.Farombi, E. O., Britton, G. and Emerole, G. O. 2000. Evaluation of the antioxidant activity and partial characterization of extracts form browned yam flour diet. Food Research International. 33: 493-499. 48.Fridovich, I. 1995. Superoxide radical and superoxide dismutases.Annu. Rev. Biochem. 64: 97-112. 49.Fuller, R. and Brooker, B. E. 1974. Lactobacilli which attach to the crop epithelium of the fowl. Am. J. Clin. Nutr. 27 : 1305-1312. 50.Gestetner, B., Brik, Y. and Tencer, Y. 1968. Soybean saponins: Fate of ingested soybean saponins and the physiological aspect of their hemolytic at activity. Journal of Agricultural and Food Chemistry. 16:1031-1035. 51.Giese, J. 1996. Antioxidants: tools for preventing lipid oxidation. Food Technol. 50(11): 73-81. 52.Green, M. J., and H. A. O. Hill. 1984. Chemistry of dioxygen.Methods Enzymol. 105: 3-22. 53.Gyamfi, M. A., M. Yonamine, and Y. Aniya. 1999. Free-radical scavenging action of medicinal herbs from Ghana Thonningia sanguine on experimentally-induced liver injuries. Gen. Pharmacol. 32:661-667. 54.Halliwell, B., M. A. Murcia, S. Chirico, and O. I. Aruoma. 1995. Free radicals and antioxidants in food and in vivo: What they do and how they work. Crit. Rev. Food Sci. Nutr. 35(1&2): 7-20. 55.Hashimoto, S., K. Nomoto, T. Matsuzaki, T. Yokokura, and M. Mutai.1984. Oxygen radical production by peritoneal macrophages and Kupffer cells elicited with Lactibacillus casei. Infection and Immunology 44: 61-67. 56.Hose H., T. Sozzi. 1991. Probiotics, fact or fiction. Journal of Chemical Technology and Biotechnology 51: 540-544. 57.Hoijer, H. P., E. E. Sterchi, D. Bienz, J. A. M. Fransen, and A. Marxer.1995. Expression and intracellular transport to microvillus membrane hydrolases in human intestinal epithelial cells. The Journal of CellBiology 101: 838-851. 58.Hossain, M. Z., L. R. Wilkens, P. P. Mehta, W. Loewenstein, and J. S.Bertram. 1989. Enhancement of gap junctional communication by retinoids correlateswith their ability to inhibit neoplastic transformation. Carcinogeneiss 10:1743-1748. 59.Hou, W. C., M. H. Lee, H. J. Chen, W. L. Liang, C. H. Han, Y. W.Liu,and Y. H. Lin. 2001. Antioxidant activities of dioscorin, the storage protein of yam (Dioscorea batatas Decne) tuber. Journal of Agricultural and Food Chemistry 49: 4956-4960. 60.Hu, K., Dong, A. J., Yao, X. S., Kobayashi, H. and Iwasaki, S. 1997a. Afurostanol glycoside from rhizomes of Dioscorea collettii var.hypoglauca. Phytochemistry. 44: 1339-1342. 61.Hu, K., Dong, A., Yao, X. S., Kobayashi, H. and Iwasaki, S. 1996.Antineoplastic agents. I. Three spirostanol glycosides from rhizomes of Dioscorea collettii var. hypoglauca. Planta Medica. 62: 573-575. 62.Hu, K., Yao, X., Kobayashi, H. and Iwasaki, S. 1997b. Antineoplastic agents. II. Four furostanol glycosides from rhizomes of Dioscorea collettii var. hypoglauca. Planta Medica. 63: 161-165. 63.Iwu, M. M., Okunji, C. O., Ohiaeri, G. O., Akah, P., Corey, D. and Tempesta, M. S. 1990. Hypoglycamic activity of Dioscoretine from tubers of Dioscorea dumetorum in normal and alloxan diabetic rabbits. Planta Medica. 56: 264-267. 64.Jin, L. Z., Y. W. Ho, N. Abdullah, and S. Jalaludin. 1998. Growth performance, intestinal microbial populations, and serum cholesterol of broilers fed diets containing lactobacillus culture. Poultry Science77: 1259-1265. 65.Johansson, M. L., Molin, G., Jeppson, B., Nobeak, S., Ahrne, S. and Bengmark, S. 1993. Administration of different Lactobacillus strains in fermented oatmeal soup: In vivo colonization of human intestinal mucosa and effect on the undigenous flora. Appl. Environ. Microbiol.59 : 15-20. 66.John,W.and Sons,I.1970.Engineering factors in single-cell protein production.Bitechnology and Bioengineering.12(1):135-140. 67.Lasztity, R., Hidvegi, M. and Bata, A. 1998. Saponins in Food. Food Reviews International. 14: 371-390. 68.Liu, TY. Etal. (1990), Prediction of Fatty Liver from Serum Triglyceride Levels and Body Weight Indexes,Kaohsiung Journal Medical Science, (6), pp.289-294. 69.Kneifel, W., Jaros, D. & Erhard, F. 1993. Microflora and acidification properties of yogurt and yogurt-related products fermented with commercially available starter cultures. Int. J. Food Microbiology, 3(3), 277-291. 70.Mattia-Sandholm, T. 1999 The effect of probiotic strains on themicrobiota of the simulator of the human intestinal microbial 3ecosystem (SHIME). Int. J. Food. Microbiol. 46 : 71-79. 71.McAnuff, M. A., Omoruyi, F. O., Morrison, and Asemota, H. N. 2001.Plasma and liver lipid distributions in streptozotocin -induced diabetic rats fed sapogenin extract of the Jamaican bitter yam (Dioscorea polygonoides). Nutritional Research. 22: 1427-1434. 72.Meydani, S. N., and W. K. Ha. 2000. Immunologic effects of yogurt.The American Journal of Clinical Nutrition 71: 861-872 73.Mohamedain MM,Fred AK.Cholesterol-rich diet have different effects on lipid peroxidation,cholesterol oxides,ad antioxidant enzymes in rats and rabbits.J.Nutr.Biochem.2000;11:293-302. 74.Morgan, B. P. and Morynihan, R. A., 1997. Steroids. pp.851-921 in Kirk-Othmer Encyclopedia of Chemical Technology, 4th ed. Johh Woely & Sons, New York. 75.Namiki, M. 1990. Antioxidants/antimutagens in food. Crit. Rev. Food Sci. Nutr. 29(4): 273-300. 76.Nibbering, C. P., Groen, A. K., Ottenhoff, R., Brouwers, J. F. H. M.,vanBerge-Henegouwen, G. P. and van Erpecum, K. J. 2001.Regulation of biliary cholesterol secretion is independent of hepatocyte canalicular membrane lipid composition: a study in the diosgenin-fed rat model. Journal of Hepatology. 35: 164-169. 77.Oyaizu M.Studies on product of browning reaction prepared from glucose amine.J J Nut,1986.44:307-315. 78.Pall, R. E., and N. J. Chen. 1988. Compositional change in yam bean during storage. HortScience 23: 194-196. 79.Perez, P. F., Y. Minnaard, E. V. Disalvo, and G. L. Antoni. 1998.Surface properties of bifidobacteria ingested via fermented milk during their passage through the human small intestine: an in vivo study using intestinal perfusion. The American Journal of Clinical Nutrition 55:78-80. 80.Perdigon, G., S. Alvarez, M. Rachid, G. Aguero, and N. Gobbato. 1995.Immune system stimulation by probiotics. Journal of Dairy Science78: 1597-1606. 81.Ranhotra, G. S., Gelroth, J. A. and Glaser, B. K. 1996. Effect of resistant starch on blood and liver lipids in hamsters. Cereal Chem.73:176-178. 82.Regnstrom J,Nilsson J.Lipid oxidation and inflammation-induced intimal fibrosis in Coronary heart disease.Journal of Laboratory and Clinical Medicine 1994;124(2):162-8. 83.Ring, S. G., J. M. Gee, M. Whittam, P. Orford, and I. T. Johnson. 1988.Resistant starch: Its chemical form in food stuffs and effect on digestability in vitro. Food Chemistry 28: 97. 84.Roman, I. D., Thewles, A. and Coleman, R. 1995. Fractionation of livers following diosgenin treatment to elevate biliary cholesterol.Biochimica et Biophysica Acta. Reviews on Cancer. 125: 77-81. 85.Salminen, S., Isolauri, E. and Salminen, E. 1996. Clinical uses of probiotics for stabilizing the gut mucosal barrier: Successful strains and future challenges. Antonie van Leeuwenhoek 70 : 347-358. 86.Savage, D. C. 1983. Roles of Lactobacillus in the intestinal tract. J. Food.Prot. 42 : 259-262. 87.Schiffrin, E. J., Brassart, D., Servin, A. L., Rochat, F. and Donnet-Hughes,A. 1997. Immune modulation of blood leukocytes in humans by lactic acid for Criteria strain seclection. Am. J. Clin. Nutr. 66: 515-520. 88.Shimiya, Y., Shimizu, M., and Shimada, A. 1992. Effects of

specific volume of air accompanying rice flour on porous struture of fermented and steamed rice bread. Nippon Shokuhin Kogyo Gakkaishi. 40: 28-34. 89.Sidhu, G. S., and Oakenfull, D. G., 1986. A mechanism for the hypocholesterolaemic activity of saponins. The Journal of Nutrition55: 643-649. 90.Sies, H. 1991. Oxidative stress: From basic research to clinical application. Am. J. Med. 91: 31-38. 91.Sievert, D. and Y. Pomeranz. 1989. Enzyme-resistant starch. Characterization and evaluation by enzymatic, thermoanalytical, and microscopic methods. Cereal Chemistry 66: 342-347. 92.Speck, M.L. 1984. Compendium of methods for the microbiological examination of foods. American Public Health Association. Washington, D.C., USA., 184-202. 93.Tannock, G. W. 1997. Probiotic properties of lactic acid bacteria: Plenty of scope for fundamental R and D. Trends in Biotechnology 15:270-274. 94.Toit, M., Franz, C. M. A. P., Disks, L. M. T., Schillinger, U., Haberer, P.,Warlies, N., Ahrens, F. and Holzafel, W. H. 1998. Characterization and selection of probiotic lactobacilli for a preliminary minipig feeding trial and their effect on serum cholesterol levels, feces pH and feces moisture content. Int. J. Food. Microbiol. 40 : 93-104. 95.Usman, L., and A. Hosono. 1999. Bile tolerance, taurocholate deconjugation, and binding of cholesterol by Lactobacillus gasseri strains. Journal of Dairy Science 82: 243-248. 96.Wanasundera, J. P. D., and G. Ravindran. 1994. Nutritional assessment of yam (Dioscorea alata) tubers. Plant Foods for HumanNutrition 46: 33-39.Wang, Y. L., L. Y. Hsin, C. C. Shi, C. C. Tien, and S. H. Yi. 1998.Purification and characterization of soluble acid invertase from yamtubers. Journal of the Chinese Agriculture and Chemistry Society 36:464-472. 97.Yamada, T., Hoshino, M., Hayakawa, T., Ohhara, H., Yamada, H.,Nakazawa, T., Inagaki, T., Iida, M., Ogasawara, T., Uchida, A.,Hasegawa, C., Murasaki, G., Miyaji, M., Hirata, A. and Takeuchi, T.1997. Dietary diosgenin attenuates subacute intestinal inflammation associated with indomethacin in rats. American Journal of Physiologica. 273: 355-364. 98.Yamaguchi, A., Tazuma, S., Ochi, H. and Chayama, K. 2003. Cholereticaction of diosgenin is based upon the increases in canalicular membrane fluidity and transporter activity mediating bile acid independent bile flow. Journal of Hepatology. 253: 287-295.