

# Studies on the Serum Lipids Reducing Effects of Four Grain Sprouts' Studies on the Serum Lipids Reducing Effects of ...

廖東垣、林麗雲；顏裕鴻

E-mail: 9608238@mail.dyu.edu.tw

## ABSTRACT

The research was to analyze general component in its contents, nutrition and the antioxidation ability as well as anti-inflammation ability of self-made wheat enzyme liquid. The results showed that the wheat enzyme liquid containing 66.5ppm total polyphenols; the half-decay concentration for NO is 92.7mg/mL; while as the half-decay concentration for PGE2 comes to 120.2mg/mL. Therefore, it ' s plain to see that the wheat enzyme liquid does contain anti-inflammation ability. In addition, the anti-LDL ability and anti-glycation ability in the wheat enzyme liquid is found better than the control group, and the suspend speed of LDL oxidation for the wheat enzyme liquid is 10.5 times to the control group. Animal tests were conducted to investigate the ability of wheat enzyme liquid in reducing blood lipids in hamsters. The method was to take 38 six-week-old male hamsters and randomly divide them into Control Group (C, six hamsters), High Blood Fat Group (H, eight hamsters), 6% Liquid Enzyme Group (H-6, eight hamsters), 12% Liquid Enzyme Group (H-12, eight hamsters), and 18% Liquid Enzyme Group (H-18, eight hamsters). The test was to run for six weeks, records of feed intake and weight changes were taken on every other day. The blood and liver samples were collected after six weeks and TG, TC, LDL-C and HDL-C in the serum as well as the content of liver TC and TG of the hamsters were analyzed. The results indicated there was no distinctive difference in the feed intake ( $P>0.05$ ) but there were distinctive difference in the weight changes in each group of hamsters; as for blood lipids, the concentration of TC, TG and HDL-C in the serum had greater distinctive differences ( $P < 0.05$ ). The TC concentration in liver had distinctive difference ( $P < 0.05$ ), while as the TG concentration had decreased though the difference was vague. In conclusion, consuming wheat enzyme liquid is able to increase HDL-C and reduce lipids in blood.

Keywords : wheat enzyme liquid、 reduce blood lipids

## Table of Contents

目錄	封面	內頁	簽名頁	授權書	iii	中文摘要	iv	英文摘要	v	誌謝	vi	目錄	vii	圖目錄	xi	表目錄	xii	1. 前言	1	2. 文獻回顧	3	2.1 麥類簡介	3	2.1.1 小麥	3	2.1.2 大麥	3	2.1.3 蕎麥	4	2.1.4 燕麥	5	2.2 麥類之機能性成分及生理功能	6	2.2.1 芸香?	8	2.2.2 槲皮酮	9	2.3 自由基的生物學定義	9	2.3.1 自由基的種類	10	2.3.2 自由基對生物體的影響	11	2.3.3 氧化壓力	12	2.4 血脂異常的分類及定義	13	2.4.1 高血脂症	13	2.4.2 臨床分類	15	2.4.3 病理分類	19	3. 實驗材料與方法	24	3.1 麥芽發酵液降血脂之探討	24	3.1.1 實驗材料	24	3.1.2 藥品與溶劑	25	3.1.3 實驗儀器	25	3.1.4 實驗方法	26	3.2 麥芽之一般成份分析	31	3.3 麥芽之營養成份分析	32	3.3.1 麥芽發酵液醣類檢測	32	3.3.2 麥芽發酵液胺基酸檢測	33	3.3.3 麥芽發酵液維生素檢測	33	3.3.3.1 複合水溶性維生素之測定 – 毛細管電泳法	33	3.3.3.2 複合脂溶性維生素之測定 – 毛細管電泳法	36	3.3.3.3 膽鹼測定	37	3.3.4 麥芽發酵液礦物質檢測	38	3.3.4.1 鈣、錳、鐵、鎂、鋅、銅、鈉、鉀之檢測	38	3.3.4.2 磷之檢測	39	3.4 麥芽發酵液酵素活性檢測	39	3.5 麥芽發酵液中有益菌分析	41	3.5.1 酵母菌菌數之測定	41	3.5.2 乳酸菌菌數之測定	41	3.6 麥芽發酵液活性抗氧化性評估	42	3.6.1 總多元酚含量測定	42	3.6.2 DPPH清除自由基能力測定	42	3.7 麥芽發酵液抗發炎能力測定	43	3.7.1 細胞培養	43	3.7.2 Nitrite之測定	43	3.7.3 PGE2之測定	44	3.8 延緩LDL氧化能力測定	44	3.9 資料統計分析	44	4. 結果與討論	46	4.1 麥芽發酵液一般成份及營養素分析	49	4.2 麥芽發酵液有益菌分析	52	4.3 麥芽發酵液酵素活性成份	52	4.4 麥芽發酵液總多元酚及清除DPPH自由基能力	54	4.5 麥芽發酵液抗發炎及延緩LDL氧化能力	56	4.6 麥芽發酵液治療高血脂功能之探討	59	4.6.1 危險因子	60	4.6.2 倉鼠飼料攝取量及體重之變化	61	4.6.3 血清中膽固醇及三酸甘油酯濃度之變化	61	4.6.4 LDL-C、HDL-C之變化	62	4.6.5 肝重及肝體重比之變化	66	4.6.6 肝臟中TC及TG濃度之變化	66	5. 結論	70	參考文獻	71	圖目錄	圖3.1 飲食試驗流程	26	表目錄	表2.1 去穀麥類營養成份分析	7	表2.2 歐洲動脈硬化學會對血脂異常之治療性分類	16	表2.3 美國國家膽固醇教育計畫依低密度脂蛋白膽固醇之血脂異常分級	16	表2.4 美國國家膽固醇教育計畫依總膽固醇之血脂異常分級	17	表2.5 美國國家膽固醇教育計畫依高密度脂蛋白之血脂異常分級	17	表2.6 美國國家膽固醇教育計畫依三酸甘油酯之血脂異常分級	18	表2.7 中華民國血脂異常分類之建議	18	表2.8 世界衛生組織依血脂表現型之分類	20	表2.9 續發性血脂異常之原因	21	表3.1 實驗飼料組成	28	表3.2 麥芽發酵液管灌之倉鼠每日灌食量	29	表4.1 麥芽發酵液中一般成份組成	47	表4.2 麥芽發酵液中醣類組成分析	47	表4.3 麥芽發酵液中胺基酸組成及含量	49	表4.4 麥芽發酵液中礦物質分析	50	表4.5 麥芽發酵液中維生素種類及含量	51	表4.6 麥芽發酵液中酵母菌和乳酸菌數分析	53	表4.7 麥芽發酵液中酵素活性分析	53	表4.8 麥芽發酵液之總多元酚含量及清除DPPH自由基能力	55	表4.9 麥芽發酵液抗發炎活性及抑制低密度膽固醇的功効評估	58	表4.10 不同誘導期及治療期間各組倉鼠每日、每隻之攝食量	62	表4.11 麥芽發酵液對倉鼠體重之影響	63
----	----	----	-----	-----	-----	------	----	------	---	----	----	----	-----	-----	----	-----	-----	-------	---	---------	---	----------	---	----------	---	----------	---	----------	---	----------	---	-------------------	---	-----------	---	-----------	---	---------------	---	--------------	----	------------------	----	------------	----	----------------	----	------------	----	------------	----	------------	----	------------	----	-----------------	----	------------	----	-------------	----	------------	----	------------	----	---------------	----	---------------	----	-----------------	----	------------------	----	------------------	----	------------------------------	----	------------------------------	----	--------------	----	------------------	----	----------------------------	----	--------------	----	-----------------	----	-----------------	----	----------------	----	----------------	----	-------------------	----	----------------	----	---------------------	----	------------------	----	------------	----	------------------	----	---------------	----	-----------------	----	------------	----	----------	----	---------------------	----	----------------	----	-----------------	----	---------------------------	----	------------------------	----	---------------------	----	------------	----	---------------------	----	-------------------------	----	----------------------	----	------------------	----	---------------------	----	-------	----	------	----	-----	-------------	----	-----	-----------------	---	--------------------------	----	-----------------------------------	----	------------------------------	----	--------------------------------	----	-------------------------------	----	--------------------	----	----------------------	----	-----------------	----	-------------	----	----------------------	----	-------------------	----	-------------------	----	---------------------	----	------------------	----	---------------------	----	-----------------------	----	-------------------	----	-------------------------------	----	-------------------------------	----	-------------------------------	----	---------------------	----

表4.12麥芽發酵液對倉鼠血漿之HDL-C、LDL-C、TC、TG含量之影響64 表4.13麥芽發酵液對倉鼠之肝重及百分肝體重比之影響67 表4.14麥芽發酵液對倉鼠肝萃取物中總膽固醇及三酸甘油酯含量之影響68 表4.15麥芽發酵液對倉鼠整肝中膽固醇及三酸甘油酯含量之影響69

## REFERENCES

- 參考文獻 1.潘威仁。2005。朱紅栓菌生物活性探討。南台科技大學生物科技系碩士論文。台南。 2.甯鈞慧。擠壓加工蕎麥粉對倉鼠血脂質及抗凝血因子之影響。食品營養研究所論文。2004。靜宜大學。台中。 3.劉立綱。2002。桑椹萃取物降血脂及預防動脈粥狀硬化形成之作用。中山醫學大學生物化學研究所碩士論文。台中。 4.劉士銘。2003。探討大豆蛋白降血脂之作用機轉。臺北醫學大學保健營養學系碩士論文。台北。 5.劉生連、黃榮貞、陳炯明、周清水。1966。自動製麩機製麩與手工製麩之比較。中國農業化學會誌4(1,2):34-37。 6.劉耀仁。2004。數種鳳梨的果實發育與自然開花的抑制。國立屏東科技大學農園生產系碩士論文。屏東。 7.林禎。1996。保健食品之簡介。食品工業月刊11:14-15。 8.高血壓防治手冊。2004。行政院衛生署。第156頁。遠流出版公司。台北，台灣。 9.金惠民。1995。疾病營養與膳食療養。第183至188頁。華香園出版社。台北，台灣。 10.許瑛珺。2002。紅龍果種籽成份分析。國立成功大學化學系碩士論文。台南。 11.趙文婉、張珍田、周淑姿。2002。淺淡植物類化學物質對抗自由基之機制。食品工業 34(2):49-60。 12.張為憲。1992。高等食品化學。第105-135頁。華香園出版社。台北，台灣。 13.鄭明清。2004。數種芹菜精油成份分析及其降血脂之研究，大葉大學生物產業科技學系碩士論文。彰化。 14.陳秀貞。2004。Leflunomide之抗發炎及其抗血小板凝集作用。中原大學化學研究所碩士論文。中壢。 15.斯崇文。1993。腸道菌群失調。中國大百科全書現代醫學卷。第112-113頁。中國大百科全書出版社。北京，中國。 16.孫蓓蓓。2002。多種水溶性及脂溶性維生素含量之測定-毛細管電泳及其他方法之評估。屏東科技大學食品科學系碩士論文。屏東。 17.楊雅露。蕎麥芽抗氧化及降血脂活性之研究。2006。弘光科技大學。台中。 18.吳文騰。2003。生物產業技術概論。第219-274頁。國立清華大學出版社。新竹，台灣。 19.王秀育。2006。熱處理對包種茶品質及抗氧化性之影響。大葉大學生物產業科技學系碩士論文。彰化。 20.王心芬。2004。五種黑色食品與其複方組合對血脂及LDL氧化之影響。國立臺灣大學食品科技研究所碩士論文。台北。 21.王怡晶。2003。蕎麥:化學組成與機能特性，食品工業發展研究所，35(12): 17-29。 22.于守洋、崔洪斌。2003。新世紀保健食品全集。第574頁。九州圖書文物有限公司。台北，台灣。 23.Ajlounim, S.O., Beelman, R.B. Thomposn, D.B. and Mau, J.L. 1995. Change in soluble sugar in various tissues of cultivated mushrooms, *Agaricus bisporus* during postharvest storage. In " Food Flavors ", Gold Coast Ingredients ING. pp. 1865-1880. 24.Asgary, S., Naderi, G., Sarrafzadegan, N., Ghassemi, N., Boshtam, M. Rafie, A., 1999. Antioxidant effect of flavonoids on hemoglobin glycosylation. *Pharm. Acta. Helv.* 7:223-226. 25.Bonafaccia, G., Marocchini, M. and Kreft, I. 2003. Composition and technological properties of the flour and bran from common and tartary buckwheat. *Food Chem.* 80:9-15. 26.Bonataccia, G. and Kreft, I. 1994. Technological and Qualitative characteristics of food products made with buckwheat. *Fagopyrum* 14:35-42. 27.Cianflone, K., Yasrael, Z., Rodriguez, M.A., Vas, D. and Sniderman, A.D. 1990. Regulation of apo B secretion from HepG2 cell: evidence for a critical role for cholesterol ester synthesis in the response to a fatty acid challenge. *J Lipid Res.*31:2045-2055. 28.Duthie, S. J. and Dobson, V. L. 1999. Dietary flavonoids protect human colonocyte DNA from oxidative attack in vitro. *Eur.J. Nutr.* 38:28-34. 29.Edited by Cody, Middleton Jr., E., Harborne J. B. and Beretz, A. Alan R. Liss, New York. pp. 283-299. 30.Elia, G., Amici, C., Rossi, A. and Santoro, MG. 1996. Modulation of prostalandin AI-induced thermotolerance by quercetin in human leukemic cell: role of heat shock protein 70. *Cancer Res.* 56:210-217. 31.FDA. 1992. Bacteriological Analytical Manual. Association of official chemists. Washington, D. C. 32.Gerster, H. 1996. Intermediate cancer bio markers and their use in carotene studies in humans. *Int. J. vitam. Nutr. Res.* 66:3-18. 33.Halliwell, B., Aruoma, O. I., Mufite, G. and Bomford A. 1988. Bleomycin - detectable iron in serum from leukaemic patients before and after chemotherapy. Therapeutic implications for treatment with oxidant-gene rating drug. *FEBS Lett.* 241:202-204. 34.Halliwell, B., Murcia, M. A. S. and Aruoma, O, I, 1995. Free radicals and antioxidants in food in vivo: What they do and how they work. *Crit. Rev. Food Sci Nutr.* 35:7-20. 35.Hansen, R. K., Oesterreich, S. and Lemieux, P. 1997. Quercetin inhibitor heat shock protein induction but not heat shock factor DNA-binding in human breast carcinoma cells. *Biochem. Biophys.Res.Commun.*239:851-856 36.Hegsted, D. 1986. Serum-cholesterol response to dietary cholesterol: a re-evaluation. *Am J. Clin Nutr.*44:299-305. 37.Horigome, T. and Cho, Y. S. 1992. Dietary casein and soybean protein affect the concentrations of serum cholesterol, triglyceride and free amino acids in rats. *J. Nutr.* 122:2273-2282. 38.Hyslop, P. A., Hinshaw, D. B., Halsy, W. A., Jachson, J. H. and Cochrane, C. G. 1988. Mechanisms of oxidant - mediated injury. *Biol. Chem.* 263:1665-1675. 39.Ihme, N., Kiesewetter, H., Jung, F., Hoffmann, K. H., Birk, A., Muller, A. and Grutzner, K. I. 1996. Legoodema protection from a buckwheat herb tea in patients with chronic venous insufficiency: a single-centre, randomised, double-blind, placebo-controlled clinical trial. *Eur. J. Clin. Pharmacol.* 50:443-447. 40.Iwata, K., Miwa, S., Inayama, T., Sasaki, H., Soeda, K. and Sugahara, T., 1990. Effects of kangra buckwheat on spontaneously hypertensive rats. *J. Kagawa Nutr. College* 21:55-61. 41.Alonso, R., Orue, E. and Marzo, F. 1998. Effects of extrusion and conventional processing methods on protein and antinutritional factor contents in pea seeds. *Food Chem.* 63:505-512. 42.Jenkins, K. J., Hidioglou, M. and Collins, F. W. 1993. Influence of various flavonoids and simple phenolics on development of exudative diathesis in the chick. *J. Agric. Food Chem.* 41:441-445. 43.Jenkins, K. J., Hidioglou, M. and Collins, F. W. 1993. Influence of various flavonoids and simple phenolics on development of exudative diathesis in the chick. *J. Agric. Food Chem.* 41:441-445. 44.John, R.B., Lisa, J.W. and Huff, M.W. 1999. Acyl coenzyme A: cholesterol acyltransferase inhibition and hepatic apolipoprotein B secretion. *Clin. Chim. Acta* 286:231-242. 45.Kaul, T. N., Middleton Jr., E. and Ogra, P. L. 1985. Antiviral effect of flavonoids on human viruses. *J. Med. Virol.* 15:71-79. 46.Kawaii, S., Tomono, Y., Katase, E., Ogawa, K. and Yano, M. 1999. Antiproliferative activity of flavonoids on several cancer cell lines. *Biosci. Biotech. Biochem.*

63:896-899. 46. Kayashita, J., Shimaoka, I., and Nakajoh, M. 1995. Hypo cholesterolemic effect of buckwheat protein extract in rat fed cholesterol enriched diets. *Nutr. Res.* 15:691-698. 47. Kayashita, J., Shimaoka, I., Nakajoh, M., Kishida, N. and Kato, N. 1999. Consumption of a buckwheat protein extract retards 7, 12-dimethylbenz [a] anthracene-induced mammary carcinogenesis in rats. *Biosci. Biotech. Biochem.* 63:1837 - 1839. 48. Kayashita, J., Shimaoka, I., Nakajoh, M., Yamazaki, M. and Kato, N. (1997) Consumption of buckwheat protein lower plasma cholesterol and raises fecal neutral sterols in cholesterol-fed rats because of its low digestibility. *J. Nutr.* 127:1395-1400. 49. Kayashita, J., Shimaoka, I., Nakajoh, M. and Kato, N. 1996. Feeding of buckwheat protein extract reduces hepatic triglyceride concentration, adipose tissue weight, and hepatic lipogenesis in rats. *J. Nutr. Biochem.* 7:555-559. 50. Knekt, P.; Kumpulainen, J., Jarvinen, R., Rissanen, H., Heliovaara, M., Reunanen, A., Hakulinen, T. and Aromaa, A. 2002. Flavonoid intake and risk of chronic diseases. *Am. J. Clin. Nutr.* 76:560-568. 51. Lapre, J.A., West, C.E., Lovati, M.R., Sirtor, C.R. and Beynen, A.C. 1989. Dietary animal proteins and cholesterol metabolism in rats. *Int J Vitam Res.* 59:93-100. 52. Li, S. Q. and Zhang, Q. H. 2001. Advances in the development of functional foods from buckwheat. *Crit. Rev. Food Sci. Nutr.* 41:451-464. 53. Lindahl, T. 1993. Instability and decay of the primary structure of DNA. *Nature* 362:709-715. 54. Liu, Z., Ishikawa, W., Huang, X., Tomotake, H., Kayashita, J., Watanabe, H. and Kato, N. A. 2001. Buckwheat protein product uppresses, 2- dimethylhydrazine - induced colon carcinogenesis in rats by reducing cell proliferation. *J. Nutr.* 131:1850-1853. 55. Loft, S. and Poulsen, H. E. 1996. Cancer risk and oxidative DNA damage in man. *J. Mol. Med.* 74:297-312. 56. Matsubara, Y., Kumamoto, H., Iizuka, Y., Murakami, T., Okamoto, H. and Yokoi, K. 1985. Structure and hypertensive effect of flavonoid glycosides in citrus unshiu peelings. *Agric Biol. Chem.* 49:909-914. 57. Middleton, E. and Kandaswami, C. 1992. Effects of flavonoids on immune and inflammatory cell functions. *Biochem. Pharmacol.* 43:1167-1179. 58. Miyazaki, A. and Koga, T. 2002. Pravastatin sodium, an inhibitor of 3-hydroxy-3-methylglutaryl coenzyme A reductase, decreases serum total cholesterol in Japanese white rabbits by two different mechanisms. *Atherosclerosis* 162:299-306. 59. Mizui, T., Sato, H., Hirose, F. and Doteuchi, M. 1987. Effect of antiperoxidative drugs on gastric damage induced by ethanol in rats. *Life Sci.* 41:755-763. 60. Murakami, J., Kondo, Y., Toda, Y., Kitojima, H. and Kameo, K. 2002. Effect of taurine on cholesterol metabolism in hamsters: Up-regulation of low density lipoprotein (LDL) receptor by taurine. *Life Sci.* 70:2355-2366. 61. Narahara, H., Kopyama, Y., Yoshida, T., Ueda, S. P. and Taguchi, H. 1982. Growth and enzyme production in a solid-state culture of *Aspergillus oryzae*. *J. Ferment. Technol.* 60(4): 311-319. 62. Nelson, N. 1944. A photometric adaptation of the Somogyi method for the determination of glucose. *J. Biol. Chem.* 153:375-380. 63. Newnham, H.H. and Barter, P.J. 1992. Changes in particle size of high density lipoproteins during incubation with very low density lipoproteins, cholesteryl ester transfer protein and lipoprotein. *Biochem. Biophys. Acta.* 1125:294-304. 64. Nicolosi, R.J. and Wilson, T.A. 1997. The anti-atherogenic effect of dietary soybean protein concentrate in hamster. *Nur Res.* 17:1457-1467. 65. Oshida, M., Saki, T., Hosokawa, N., Marui, N., Matsunoto, K. and Fujioka, A. 1990. The effect of quercetin on cell cycle progression and growth of human gastric cancer cells. *FEBS Lett.* 260:10-13. 66. Pisha, E. and Pezzuto, J. M. 1994. Fruits and vegetables containing compounds that demonstrate pharmacological activity in humans. In *Economic and Medical Plant Research*, vol.6; Wagner, H., Hikino, H., Fransworth, N. R., Eds.; Academic Press: London, UK, pp.189-233. 67. Rotelli, A. E., Guardia, T., Juarez, A. O., Rocha, N. E. and Pelzer, L. E. 2003. Comparative study of flavonoids in experimental models of inflammation. *Pharmacol Res.* 48:601-606. 68. Ruch, R. J., Cheng, S. and Klaungig, J. E. 1989. Prevention of cytotoxicity and inhibition of intercellular communication by antioxidant catechin isolated from Chinese green tea. *Carcinogenesis* 10: 1003-1008. 69. Sanchez de Medina, F., Galvez, J., Romero, J. A. and Zarzuelo, A. 1996. Effect of quercitrin on acute and chronic experimental colitis in the rat. *J. Pharmacol. Exp. Ther.* 278:771-779. 70. Sies, H. 1991. Oxidative Stress: from basic research to clinical application. *Am. J. Met.* 91:31s-38s. 71. Somogyi, M. 1952. Notes on sugar determination. *J. Biol. Chem.* 195:19-23. 72. Sugano, M. and Imaizumi K. 1995. Effect of different saturated fatty acid as interesterified triacylglycerols on lipid metabolism in rats and hamster. *J. Nutr. Biochem.* 6:195-200. 73. Sure, B., 1995. Nutritive value of proteins in buckwheat and their role as supplement to proteins in cereal grain. *J. Agric. Food chem.* 34:764. 74. Tomotake, H., Shimaoka, I., Kayashita, J., Yokoyama, F. and Nakajoh, M. 2000. A buckwheat protein product suppresses gallstone formation and plasma cholesterol more strongly than soy protein isolate in hamsters. *J. Nutr.* 130:1070-1074. 75. Trnovsky, J., Letoureneau, R., Haggog, E., Boucher, W. and Theoharides, T. C. 1993. Quercetin-induced expression of rat mast cell protease II and accumulation of secretory granules in rat basophilic leukaemia cell. *Biochem. Pharmacol.* 46:2315-2316. 76. Tsai, C. E., Teng, L. and Lin, Yuling. 2005. Effect of young barley leaf essence on serum lipids in hamsters. *Nutr. Sci J.* 80:26-27. 77. Varma, S. D. 1986. Inhibition of aldose reductase by flavonoids: possible attenuation of diabetic complications. *Prog. Clin. Biol. Res.* 213:343-358. 78. Vlietinck, A. J., Vanden Berght, D. A. and Haemers, A. 1988. Present status and prospects of flavonoids as anti-viral agents. In *Progress in Clinical and Biological Research*. Vol.280. 79. Velioglu, Y. S., Mazza, G., Gao, L., and Oomah, B. D. 1998. Antioxidant activity and total phenolics in selected fruit, vegetables, and grain products. *J. Agr. Food Chem.* 46: 4113-4117. 80. Wang, M. Y. and Liehr, J. G. 1995. Lipid hydroperoxide-induced endogenous DNA adducts in hamsters: possible mechanism of lipid hydroperoxide-mediated carcinogenesis. *Arch. Biochem. Biophys.* 316:38 - 46. 81. Yazzie, D.; Vanderjagt, D.J.; Pastuszyn, A.; Okolo, A.; Glew, R.H. 1994. The Amino Acid and Mineral Content of Baobab ( *Adansonia digitata* L. ) Leaves. *J. Food Comp. Anal.* 7, 189-193. 82. Yildizoglu-Ari, N., Altan, V. M., Altinkurt, O. and Ozturk, Y. 1991. Pharmacological effects of rutin. *Phytotherapy Res.* 5:19-23. 83. Yin, L. J., Pan, C. L. and Jiang, S. T. 2002. Effect of lactic acid bacterial fermentation on the characteristics of minced mackerel. *J. Food Sci.* 67: 786-792. 84. Zarkadas, C.G., Zarkadas, G. C., Karatzas, C.N., Khalili, A.D., Nguyen, Q. 1986. Rapid method for determining esmosine, isodesmosine, 5-hydroxylysine, tryptophan, lysinoalanine and the amino sugars in proteins and tissues. *J. Chromatogr.* 378, 67-76. 85. Zarkadas, C.G., Drouliscos, N., Karatzas, C.J. 1988. Comparison of the total protein, nitrogen and amino acid composition of selected additives and ingredients used in composite meat products. *J. Agric. Food Chem.* 36, 1131-1146. 86. Zhang, Z., Wilson, R.P., 1998. A modified enzymatic

assay for quantifying choline in fish tissue and common feed ingredients. *J. Agric. Food Chem.* 46, 3673-3676.