UNIVERSITI PUTRA MALAYSIA

CHEMICAL COMPOSITION AND HYPOCHOLESTEROLEMIC EFFECTS OF WHITE RICE, BROWN RICE AND GERMINATED BROWN RICE (*ORYZA SATIVA L.*) IN ATHEROSCLEROSIS-INDUCED RABBITS

KHAIRUL KAMILAH ABDUL KADIR

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Chairman: Assoc. Prof. Zulkhairi Amom, PhD

Faculty: Medicine and Health Sciences

Many studies have reported the beneficial effect of BR consumption which mostly related to the bran layer of the rice kernels. Germinated brown rice (GBR), an improved product of BR is simply produced by soaking BR in water for certain duration. Even though the beneficial effect of germinated seeds has been well established, however the cardioprotective effect of GBR is still unknown. Therefore, this study was conducted to analyze nutritional value and antioxidant activity of WR, BR and GBR and to determine the cardioprotective effect of WR, BR and GBR-containing diets against hypercholesterolemia in hypercholesterolemic-induced rabbits.

Proximate analyses of WR, BR and GBR were determined by AOAC (1996) methods. Minerals content were analyzed using atomic absorption spectrophotometer (AAS). Antioxidant activity was determined by free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric thiocyanate (FTC) and thiobarbituric acid (TBA) methods. Forty two

male New Zealand white (NZW) rabbits were used and grouped as; NC (normal diet, n=7), PC (normal diet enriched with 0.5% cholesterol, n=7), WR (30% of white rice enriched with 0.5% cholesterol, n = 7), BR (30% of brown rice enriched with 0.5% cholesterol, n=7), GBR (30% of germinated brown rice enriched with 0.5% cholesterol, n=7) and SG (simvastatin enriched with 0.5% cholesterol, n=7). Blood samples were collected for plasma lipid analyses, antioxidant enzymes, plasma liver toxicity enzymes and total antioxidant status at week 0, 5 and 10 respectively while the aorta was excised for assessment of atherosclerotic plaques and histological observation at termination.

The BR and GBR sample presents a significantly higher content of ash (1.44%) than WR (0.56%) ($p<0.05$) as a result of high amount of minerals such as natrium and calcium. Germinated brown rice also contain high levels of protein (8.4%), dietary fiber (11.2%) and fat (2.57%); which were significantly higher compared to WR but significantly lower than that of BR ($p<0.05$). The high level of fat in GBR was balanced with the composition of monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA). The BR and GBR also showed high content of tocopherol, tocotrienol and oryzanol compared to WR ($p<0.05$). Brown rice and GBR expressed the highest antioxidative activities in comparison to that of WR in FTC and TBA methods, meanwhile DPPH assay denoted strong antioxidant activity in GBR with lower IC_{50} at 204µg/ml compared to that of WR and BR. Plasma samples of BR and GBR-fed rabbits showed low levels of total cholesterol (TC) and low density liporprotein (LDL) than other groups at week 10 ($p<0.05$). High density lipoprotein (HDL) also was highest in GBR-fed rabbits compared to other treated groups ($p<0.05$). Feeding rabbits with GBR also reveals a favourable effect towards a reduction of atherosclerosis in the aorta by

70%. The aorta of rabbits fed with GBR also showed the nonexistence of foam cell when observed with Transmission Electron Microscope (TEM), comparable with the NC and SG groups.

As a conclusion, the nutritive value of BR and GBR appeared to be responsible for the reduction of cholesterol levels and procrastinating the atherosclerotic plaque formation in rabbits induced with high cholesterol-diet. GBR was found to be more effective anti-atherogenic agents compared to WR and BR. Therefore, BR and GBR possess a strong preventive effect against free radical-mediated diseases such as cardiovascular disease (CVD), atherosclerotic disease or coronary heart disease.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan Ijazah Master Sains

KOMPOSISI KIMIA DAN KESAN HIPOKOLESTEROLEMIK BERAS PUTIH, BERAS PERANG DAN BERAS PERANG CAMBAH (*ORYZA SATIVA L.*) KE ATAS ARNAB YANG DIARUH ARTERIOSKLEROSIS

Oleh

KHAIRUL KAMILAH ABDUL KADIR

Januari 2012

Pengerusi: Prof. Madya Zulkhairi Amom, PhD

Fakulti: Perubatan dan Sains Kesihatan

Banyak kajian menunjukkan kebaikan beras perang (BR), di mana bergantung pada lapisan sekam beras. Beras perang cambah (GBR), beras perang yang telah diperbaiki dihasilkan dengan merendam beras perang dalam air untuk satu tempoh masa. Walaupun kesan baik anak benih cambah telah diketahui, namun kesan pencegahan kepada penyakit jantung masih belum diketahui. Oleh itu, kajian ini telah dijalankan untuk menganalisa kandungan pemakanan dan antioksida beras putih, beras perang dan beras perang cambah dan mengesan kesan pencegahan penyakit jantung beras putih (WR), beras perang (BR) dan beras perang cambah (GBR) yang terdapat dalam diet ke atas arnab yang diaruh hiperkolesterolemia.

Analisa kandungan pemakanan WR, BR dan GBR telah dilakukan dengan kaedah AOAC (1996). Kandungan mineral dianalisa dengan menggunakan mesin penyerapan atom spektrofotometer (AAS). Kandungan antioksida dianalisa dengan kaedah radikal bebas 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferik tiosianat (FTC) dan asid

thiobarbiturik (TBA). Empat puluh dua arnab putih New Zealand (NZW) telah digunakan dan dibahagikan kepada kumpulan; NC (diet normal, n=7), PC (diet normal dikayakan dengan 0.5% kolesterol, n=7), WR (30% beras putih dikayakan dengan 0.5% kolesterol, n = 7), BR (30% beras perang dikayakan dengan 0.5% kolesterol, n=7), GBR (30% beras perang cambah dikayakan dengan 0.5% kolesterol, n=7) and SG (simvastatin dikayakan dengan 0.5% kolesterol, n=7). Sampel darah telah diambil untuk analisis lipid, enzim antioksida, enzim ketoksikan hati dan status jumlah antioksida pada minggu 0, 5 and 10, manakala aorta pula dikeluarkan di hujung ekperimen untuk pengiraan plak aterosklerotik dan pemerhation histologi.

Sampel beras perang (BR) dan beras perang cambah (GBR) mengandungi jumlah abu (1.44%) yang lebih tinggi secara signifikan berbanding WR (0.56%) ($p<0.05$), sejajar dengan mengandungi mineral yang tinggi seperti natrium dan kalsium. GBR juga mengandungi protein (8.4%), serat (11.2%) dan lemak (2.57%) yang tinggi; yang lebih signifikan tinggi berbanding WR tapi rendah secara signifikan berbanding BR($p<0.05$). Kandungan lemak yang tinggi dalam GBR distabilkan dengan kandungan asid lemak mono tak tepu (MUFA) dan asid lemak poli tak tepu (PUFA). BR dan GBR juga mengandungi tokoferol, tokotrienol dan oryzanol yang tinggi berbanding WR dan BR($p<0.05$). GBR menunjukkan aktiviti antioksida yang tinggi berbanding WR dan BR dalam kaedah FTC dan TBA, manakala kaedah DPPH menunjukkan kesan antioksida yang tinggi dalam GBR dengan IC_{50} yang rendah pada 204µg/ml berbanding WR dan BR.

Sampel plasma arnab yang diberi makan BR dan GBR menunjukkan aras jumlah kolesterol (TC) dan lipoprotein berpadatan rendah (LDL) yang rendah berbanding kumpulan yang lain pada minggu ke-10. Lipoprotein berpadatan tinggi (HDL) telah menunjukkan pada tahap paling tinngi dalam kumpulan arnab yang diberi makan GBR berbanding kumpulan lain ($p<0.05$). Arnab yang diberi makan GBR juga telah menunjukkan kesan yang baik dalam pengurangan aterosklerosis dalam aorta pada 70%. Aorta arnab yang diberi makan GBR juga telah menunjukkan ketidakhadiran sel sabun apabila diperhatikan dengan TEM, setanding dengan kumpulan NC dan SG.

Sebagai kesimpulan, kandungan pemakanan BR dan GBR memainkan peranan penting untuk menurunkan aras kolesterol dan melambatkan pembentukan ateroma plak pada arnab yang diaruh dengan diet yang tinggi kolesterol. GBR lebih efektif sebagai agen anti-aterogenik berbanding WR dan BR. Oleh itu, BR dan GBR dapat bertindak sebagai pencegah yang kuat terhadap penyakit yang melibatkan radikal bebas seperti penyakit kardiovaskular (CVD), penyakit aterosklerosis atau penyakit jantung koronari.

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I certify that a Thesis Examination Committee has net on _____ to conduct the final examination of Khairul Kamilah Abdul Kadir on her thesis entitled "Nutritional Composition and Hypocholesterolemic Effect of Malaysian Germinated Brown Rice in Atherosclerotic-Induced Rabbits" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A)106 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Examination Committee were as follows:

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Date: 14 Februari 2012

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Sciences. The members of the Supervisory Committee are as follows:

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Date: 14 Februari 2012

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any institutions.

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KHAIRUL KAMILAH ABDUL KADIR

Date: 14 Februari 2012

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