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Eat adequate amount of rice, other cereal products (preferably whole grain) and tubers

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1. Terminology

Breads

Breads refer to leavened and unleavened wholemeal, white, mixed-grain, rye and fruit breads, as well as *roti canai, chapatti, tosai*, pita bread, bun, pizza, *roti arab*, rolls, bagels, muffins and crispbreads.

Cereals

Cereals refer to the entire class of cereal foods, including whole or partially processed cereal grains. It includes rice, breads, breakfast cereals, noodles, pasta, oats, corn and barley. Others are plain cereal products such as flour, semolina, bran and wheatgerm. It excludes cereal-based products with a significant amount of added fat and sugar.

Noodles and pasta

Noodles and pasta include a wide range of Asian and Italian products based on sheets of dough made from flour usually wheat or rice flour and water, sometimes with egg added. Examples are *mi, bihun, kuey teow, laksa,* egg noodles, udon, spaghetti and macaroni. The term excludes some instant noodles and flavoured pasta mixes with significant amounts of added fat and salt.

Rice

Rice refers to rough rice, brown rice, milled white rice, large broken rice, small broken rice, parboiled rice, glutinous rice, rice hulls, rice bran and rice flour.

Tubers

Tubers refer to fleshy underground swelling of stem or root strands that normally contain varying amount of starch.

Whole grain

Whole grain refers to cereal foods that consist of the intact, ground, cracked or flaked caryopsis which incorporate all the components of the natural grain, including the bran and germ. Foods that contain at least 51% by weight of any combination of wholegrains can be termed whole grain (Jacobs *et al.,* 2000). These include brown rice, dark breads, whole grain ready-to-eat cereals, cooked cereal, popcorn, wheat germ and bran (Liu, 2003). However in most studies, foods are also defined as whole grain if at least 25% is whole grain or bran by weight (Jacobs *et al.*, 2000).

When the bran and germ of the grain, which contain the major amount of nutrients and dietary fibre, have been removed and only the starchy inner part of the grain remains, the grain is now termed as refined-grain products.

Wholemeal bread

Wholemeal bread is a mixture of wholemeal

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wheat flour and wheat flour containing not less than 60% of wholemeal wheat flour and water (MOH, 1985).

2. Introduction

Cereals and cereal-based products are the most important source of food and provide the major source of energy and protein. Eight types of cereals, namely wheat, maize, rice, barley, sorghum, oats, rye and millet–provide more than 56% of the energy and 50% of the protein consumed by the world population (Cordain, 1999). Cereal grains form the basis of diets in many different cultures and cuisines. Other than being an excellent source of carbohydrate and protein, whole grain cereals are an important source of fibre, vitamins, minerals, lignans and other phytochemicals, (Slavin *et al.,* 1999), notably iron, zinc, magnesium and phosphorus (FAO, 2002). The inherent property of insoluble grain fibre is the relatively high antioxidant activity such as phenolic acids, flavonoids, tocopherols and avenanthramides.

Eating enough cereal foods help to ensure an adequate nutritional intake. Cereals would be an excellent choice to provide more than 55% of total energy for optimal health as recommended by Food and Agriculture Organization (FAO, 2002). Ling, Wang & Ma (2002) reported that carbohydrate intake especially in rice has a cardio-protective effect and was associated with low incidence of atherosclerosis or coronary heart disease (CHD) in China compared to other countries. This may be attributed to the fact that about 60% of the energy in Chinese diet is carbohydrate, which is derived mainly from rice. For over three billion people, particularly those who live in developing countries, rice is the main source of calories, providing approximately 700 calories/person/day (FAO, 2004). Other nutrients such as fibre, thiamine, niacin, vitamin B_6, iron, phosphorus, magnesium and potassium would only present significantly in rice if it is consumed together with its bran (Bird *et al.,* 2000).

Ecologically, a high-carbohydrate diet based on cereals makes good use of the world's resources since grain crops require relatively low input resources per unit of food energy produced. For these reasons, all current dietary guides have cereal foods as the largest component of the recommended daily food intake. For the last 3000 to 4000 years, a majority of the world's population has relied upon whole grains as a main proportion of the diet. It is only within the past 100 years that a majority of the population has consumed refined grain products (Slavin, 2006).

Root and tuber crops are consumed as staple food in many countries in the world, however, their contribution to the energy supply of population varies within a large range depending on the country. Many species and varieties are consumed but three species such as cassava, Irish potato and sweet potato provide more than 90% of the root and tuber crops used for direct human consumption.

While Malaysian consumption data is lacking, it is estimated that in Southeast Asia, sweet potato, Irish potato, cassava and other root and tuber represent 48%, 31%, 18% and 3% of the total directly consumed root and tuber crops respectively. About 35% of total root and tuber crops and 85% of sweet potato used as human staple food are consumed in Southeast Asia (FAO, 1990).

3. Scientific basis

Among the staples, rice has the highest protein digestibility. Potato protein has a higher biological value than cereal proteins,

consistent with its high amino acid score, but its net protein utilisation is lower than that of rice. The protein level of rice is similar to those of potato and yam on a dry weight basis. Utilisable protein is comparable in brown rice, wheat, maize, rye, oats and potato but is lower in sorghum and higher in millet. Rice has the highest energy digestibility, probably in part because of its low dietary fibre and tannin content. Comparison of the main root and tuber to cereal amino acid composition shows that protein quality of roots and tubers are often higher than those of cereals, particularly for lysine. Fat content of root and tuber crops is very low as it is mainly made of structural lipids of the cell membrane. The low fat, high moisture and relatively high fibre content of roots and tubers result in a slightly lower energy content than the cereals.

Hippocrates described the health benefits of whole grain bread as early as in 4 B.C. Presently, whole grain foods have been recognised to promote significant health benefits (McIntosh *et al.,* 2003). The consumption in their natural form with the presence of bran and germ could lower the risk of chronic diseases (Pereira *et al.,* 2002). This is due to the fact that whole grain differ from refined grains in the amount of vitamins, minerals and other protective substances, but the most obvious difference is the content of dietary fibre.

Dietary fibre has been well established to have beneficial physiological effect on human health (Leinonen *et al.,* 1999) and may provide protection against many diseases (Khusi, Meyer & Jacobs, 1999). It plays an important role in decreasing the risks of many disorders such as diabetes, cardiovascular diseases (CVD), constipation (Champ & Guillon, 2000), diverticulosis and obesity (De Carvalho *et al.,* 2006). The Malaysian Dietary Guidelines (NCCFN, 1999) has recommended the consumption of dietary fibre between 20 g to 30 g per day. Studies showed that the intake of dietary fibre less than 20 g per day over the course of a lifetime is associated with the development of numerous health problems (Marshall & Wadsworth, 1994).

Milling using modern technology produces fine flours with very small particle size and also removes the outer bran layer and most of the germ. The refined grain products contain more starch but lose a substantial amount of dietary fibre, vitamins, minerals, essential fatty acids and phytochemicals. The refined grains are digested and absorbed more rapidly and tend to cause more rapid and larger increases in concentrations of blood glucose and insulin than whole grain products. Milling has different effects on the bran and germ. In the case of rice, the bran and germ come away together and the resultant bruising releases the lipases which interact with the oil content leading to early rancidity of the combined germ and bran. Undermilling has been employed to retain B vitamins in milled rice, but the shelf-life of undermilled rice is shorter than that of milled rice and the product is less white. Some consumers remill the undermilled rice to remove the rancid outer layer and to make the rice whiter, with an accompanying loss of B vitamins (Tovey & Hobsley, 2004).

3.1 Diabetes

Epidemiological studies consistently show that the risk for type 2 diabetes mellitus is decreased with the consumption of whole grains (van Dam *et al.,* 2002). Dietary fibre, magnesium and vitamin E in whole grains are important components in insulin metabolism. Relatively high intakes of these nutrients from whole grains may prevent hyperinsulinaemia. However, dietary fibre seems to be the most important component in cereal grains in controlling blood glucose level. It was

associated in improving postprandial serum glucose and insulin sensitivity and subsequently decreased the risk of diabetes (Morgan *et al.,* 1990). This inverse relationship between high fibre intake and a lower risk of type 2 diabetes has been shown in both epidemiological (Fung *et al.,* 2002) and cohort studies (Schulze *et al.,* 2007).

In a randomised cross-over study, intake of purified insoluble cereal fibre for three days has increased insulin sensitivity (Weickert *et al.,* 2006). Intake of these fibre has been shown to stimulate the acute secretion of glucose-dependent insulinotropic polypeptide and insulin, reducing the glucose response to a meal in the following day (Weickert *et al.,* 2005). Subjects who consumed whole grain diet also showed improved insulin sensitivity (Pareira *et al.,* 2002).

In a randomised clinical trial, 27 healthy subjects has shown a significant reduction in glucose levels as well as LDL-cholesterol after consuming approximately 30.5 g fibre/day for a period of three months (Aller *et al.,* 2004). In both healthy and type 2 diabetic patients, consumption of brown rice lowered blood glucose response compared to milled rice (Panlasigui & Thompson, 2006).

It has been suggested that dietary fibre improves glycaemic response and insulin concentration by slowing the digestion and absorption of food as well as by regulating several metabolic hormones (Meyer *et al.,* 2000; Yang *et al.,* 2003). These mechanisms are thought to be brought about by soluble fibre (Ohara, Tabuchi & Onai, 2000). The soluble fibre also slows down the absorption and digestion of carbohydrates which lead to a reduced demand for insulin (Khor, 1997). Nevertheless, the synergistic effect of several wholegrain components, such as phytochemicals, vitamin E, magnesium, or others, may be involved in the reduction of the risk for type 2 diabetes mellitus.

3.2 Coronary heart disease (CHD)

Several nutrients in cereals, if consumed in adequate amounts, have been shown to reduce the risk factors for CHD. The predominantly polyunsaturated fatty acids (50% linoleic acid) and possibly some of the fibre could lower plasma LDL-cholesterol, while the vitamin E and selenium are antioxidants, together with folic acid might lower plasma homocysteine. It was suggested that phytoestrogens, via hormonal effect on HDL, could influence the risk of CHD, but evidence for this is lacking. Other likely candidates for some protective potential against CHD are phenolic acids, found in the outer layers of cereal grains, which are antioxidants in vitro. These phenolic acids may not benefit the circulatory system unless they could be absorbed in adequate amounts. Vitamin E, a known antioxidant, is fairly well absorbed in humans.

During the past decade, numerous key epidemiologic studies relating dietary fibre intake and cardiovascular disease have been published. Taken together, these studies provide remarkably consistent evidence that dietary fibre is likely to be inversely associated with risk of heart disease. There is evidence linking the consumption of whole grains to a reduced risk for CHD (Anderson, 2002). Morris, Marr & Clayton (1977) followed 337 subjects for 10 to 20 years and concluded that the reduction in heart disease risk was attributable to a higher intake of cereal fibre. Another study by Leinonen *et al.,* (1999) found that wholemeal rye bread was effective in reducing serum total cholesterol and LDL-cholesterol in healthy men with elevated serum cholesterol concentrations.

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Aller *et al.,* (2004) suggested that dietary fibre was associated to a decreased risk of mortality from cardiovascular disease (CVD), independent of energy and fat intake or other dietary factors. A meta-analysis of 67 controlled trial studies found a significant decrease of total cholesterol and LDL cholesterol after consuming pectin, oat bran, guar gum and psyllium. Turpeinen *et al.,* (2000) showed that increment of fibre intake from 12 to 18 g/day was associated with a 25% reduction in ischemic heart disease (IHD) mortality. When fibre intake was 10 g higher, the risk of coronary death was further reduced by 17%. Dietary fibre in different sources such as in cereals as compared to vegetables and fruits has a stronger association to a reduced risk of CHD (Leinonen, Poutanen & Mykkanen, 2000). Varied fibre content in the diet also would have different effects on serum lipids (Lovejoy *et al.,* 2002).

The ability of soluble fibre to reduce CVD risk was partly related to its ability to alter blood lipids and lipoproteins (Davy *et al.,* 2002). Studies showed that other CVD related benefits of fibre include decreased in transit time, increase fecal lipid (Lee *et al.,* 2004), reduction of cholesterol absorption and increased cholesterol catabolism into bile acids (Jenkins *et al.,* 2004). Soluble fibre also impede cholesterol biosynthesis by the action of short chain fatty acids produced by colonic microflora (Davidson & McDonald, 1998) and inhibit hepatic production of lipoproteins (Maki *et al.,* 2003; Aller *et al.,* 2004). In addition, fibre helps bile salt absorption in intestinal wall, thus preventing bile salt reabsorption either with or without dietary cholesterol absorption. This circumstance leads to an increase of bile salt synthesis and enhanced LDL catabolism (Gerhardt & Gallo, 1998).

3.3 Gastrointestinal health

Dietary fibre is one of the important nutrients associated with bowel health. It was found to be associated with a reduction of chronic constipation, diverticulitis and some types of irritable bowel symptom (Kantor *et al.,* 2001). Besides dietary fibre, whole grain are rich sources of fermentable carbohydrates including resistant starch and oligosaccharides. The oligosaccharides, with a low (2 to 20) degree of polymerisation, can have similar effects as soluble dietary fibres in the human gut and they have consistently been shown to alter human fecal flora. These undigested carbohydrates that reach the colon are fermented by the intestinal microflora to produce short-chain fatty acids such as acetic, butyric and propionic acids. Short-chain fatty acid butyrate, for instance is a preferred fuel for the colonic mucosa cells to proliferate to produce mucus for lubrication.

Dietary fibre could also improve colonic function by modulating gastrointestinal transit time, fecal weight, acidity and bile acid (Spiller *et al.,* 2003). The action involved water holding and slowing fermentation of fibre which increases bacteria in stool. Thus, it helps in increasing stool weight and promotes normal laxation. Although little research has been conducted directly on whole grains and bowel function, it is well known that dietary fibre from grains such as wheat and oats increases stool weight and speed transit (Marlett, McBurney & Slavin, 2002). The beneficial effects of dietary fibre in the large intestine is dependent on its fermentability, which is influenced by chemical composition, solubility, physical form and the presence of lignin and other compounds (Grasten *et al.,* 2000). A fibre that is rapidly fermented in the latge bowel, especially soluble fibre, results in only a small increase in stool weight (Cummings, 1993)

3.4 Cancers

There are a large number of studies investigating the relationship between consumption of whole grains and the risk of cancer. There is evidence that dietary fibre in whole grains reduces risk for specific cancers, such as stomach (Terry *et al.,* 2001), mouth and throat and upper digestive tract (Kasum *et al.,* 2002), and endometrial (Kasum *et al.,* 2001). There is also a clear dose-response relationship from generally consistent cohort studies that foods containing dietary fibre probably protect against colorectal cancer (WCRF, 2007). Peter, Sinha & Chatterjee (2003) reported that high fibre intake reduces colorectal adenoma by 27% compared to low fibre intake. Fibre exerts several effects in gastrointestinal tract but the precise mechanisms for its probable protective role are not clearly understood.

Fibre was thought to protect from breast cancer by binding enteral carcinogen and endogenous sex hormones on enterohepatic cycling (Hanf & Gonder, 2005). Cereals, as a source for dietary fibre, contain lignin which have a protective effect on hormone-related cancer (Goldberg, 2003). The lignin is a type of phytoestrogen which is transformed by bacteria in the gut into a similar structure of mammalian lignans (Truswell, 2002). Dietary factors, such as fibre, vitamin B_6 and phytoestrogen intake and lifestyle factors such as exercise, smoking and alcohol use, which are controlled for in most epidemiological studies, do not explain the apparent protective effect of whole grains against cancer, suggesting it is the whole-grain "package" that is effective.

3.5 Obesity

Studies suggested that there is an association between whole grain intake and the regulation of body weight (Pereira *et al.,* 2002). In the Coronary Artery Risk Development in Young Adults Study, whole grains were inversely associated with BMI and waist-hip ratio at baseline and 7 years later (Pereira *et al.,* 1998). Although the differences were modest, the risk for weight gain and the development of overweight or obesity could be substantially decreased. The intake of whole grains also appears to prevent weight gain among middle-aged women (Liu, 2003). In the Nurses' Health Study, the subjects who consumed more whole grains consistently weighed less than the women counterpart who had lower consumption of whole grains.

In feeding experiments, it has been shown that subjects would tend to eat to a constant weight of food. This is important as in real life, people rarely eat foods of a different energy density but similar weight or portion size (Mazlan, Horgan & Stubbs, 2006). Whole grain foods have high volume, low-energy density and the relatively lower palatability may promote satiety. Additionally, whole grains may enhance satiety for up to several hours following a meal. Obesity is associated with low fibre intake. Grains rich in viscous soluble fibres tend to increase intraluminal viscosity, prolong gastric emptying time, and slow nutrient absorption in the small intestine. Although total energy intake and overall nutrient density appear to be the most important factors affecting weight regulation, a high-fibre, low-fat diet is recommended for maintenance of body weight and prevention of obesity.

4. Current status

Malaysia produced a total of 2.24 million tonnes of rice in 2005 (FAO, 2004). The Malaysian Adult Nutrition Survey (MANS) 2003 showed intake of cereals, cereal products and tubers among the

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population was 9.9 servings/day. From this food group, rice was the obvious staple with 97% of the population eating rice twice daily at an average of 2½ plates per day (Norimah *et al.,* 2008). This consumption pattern was in line with the previous Malaysian Dietary Guidelines recommendation of eight to twelve servings per day (NCCFN, 1999). Food intakes measured using a semi-quantitative questionnaire (FFQ) comprising a total of 126 food items commonly available in Malaysia, of which 21 were cereal and legume products, showed that an adult eats approximately 744 g of cereals, cereal products, legumes and legume products per day (MOH, 2006).

It is estimated that dietary energy from roots and tuber crops has dropped by 42% during the 1992 to 1994 period than during the 1972 to 1974 period for Asian and Pacific region. According to the FAO estimates, roots and tuber crops consumption in Malaysia contributes about 56 kcal/capita/day in 2003, down from 75 kcal/capita/day in 1993 (FAOSTAT, 2009).

The low intake is attributed to processing and marketing constraints of roots and tuber crops; and changes in food habits related to the increase in the proportion of urban people. Roots and tuber crops are not only consumed as staple foods but processed into other food products. For example, cassava is mainly processed into cassava flour, cassava pearl and cassava chips. Cassava starch is a major raw ingredient of many food related industries. It is used in the manufacture of glucose and caramel, yeast and confectionery as well as in the manufacture of alcohol and monosodium glutamate, a flavour enhancer.

Studies on status of fibre intake in Malaysia produced a wide range of results. However, none of them achieved the recommended level for at least 25 g per day. Ng (1997) estimated that a Malaysian adult habitual daily diet contains about 180 g of vegetables plus fruits, providing only about 13 g to 16 g total dietary fibre. In another study among cancer patients, dietary fibre intake was also found to be low, with an average of 11 g per day (Suzana, Azhar & Fatimah, 2004). More recently, Hanapi (2008) reported that the mean fibre intake among type 2 diabetic patients was relatively very low at only 7.5 g per day.

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5. Key recommendations

Key recommendation 1

Consume at least four servings of cereal foods daily.

How to achieve

1. Eat rice or other cereal foods at every main meal.
2. Choose grain based snacks.
3. Tubers can be consumed as alternative to rice or cereal products.

Key recommendation 2

Choose at least half of your grain products from whole grains.

How to achieve

1. Cook white rice mixed with brown rice.
2. Choose whole grain alternatives for bread, biscuits and cereal products.
3. Use whole grains such as oats and barley as extenders to soups.
4. Read food labels for whole grain content.

Key recommendation 3

Choose cereal products that are high in fibre, low in fat, sugar and salt.

How to achieve

1. Choose high fibre breakfast cereals such as oats.
2. Choose high fibre biscuits that are low in fat, sugar and salt.

References

Aller R, de Luis DA, Izaola O, Calle FL, Olmo LD, Fernandez L, Arranz T & Hernandez JMG (2004). Effect of soluble fibre intake in lipid and glucose level in healthy subjects: a randomized clinical trial. *Diabetes Res Clin Pract* 65: 7-11.

Anderson JW (2002). Whole-grains intake and risk for coronary heart disease. In : *Whole-Grain Foods in Health and Disease,* pp. 187–200. L Marquart, JL Slavin and RG Fulcher, editors. Eagan Press, St Paul MN.

Bird AR, Hayakawa T, Marsono Y, Gooden JM, Record IR, Correll RL & Topping DL (2000). Coarse brown rice increases fecaln and large bowel short-chain fatty acids and starch but lowers calcium in the large bowel of pigs. *J Nutr* 130(7): 1780-1787.

Champ M & Guillon F (2000). Structural and physical properties of dietary fibres, and consequences of processing on human physiology. *Fd Res Int* 33: 233-245.

Cordain L (1999). Cereal grains: humanity's double-edged sword. *World Rev Nutr Diet* 84:19-73.

Cummings JH (1993). The effect of dietary fibre on fecal weight and composition. In. Spiller, G.A. (ed), *CRC handbook of dietary fiber in human nutrition.* 2nd ed. page 263. CRC Press, USA.

Davidson MH & McDonald A (1998). Fibre: forms and functions. *Nutr Res* 18: 617–624.

Davy BM, Davy KP, Ho RC, Beske SD, Davrath, LR & Melby CL (2002). High-fibre oat cereal compared with wheat cereal consumption favorably alters LDL-cholesterol subclass and particle numbers in middle-aged and older men. *Am J Clin Nutr* 76:351-358.

De Carvalho EB, Vitolo MR, Gama CM, Lopez FA, Taddei JAC & De Morris MB (2006). Fibre intake, constipation, and o verweight among adolescents living in Sao Paulo city. *Nutrition* 22(7-8): 744-749.

FAO (1990). Roots, tubers, plantains and bananas in human nutrition. FAO Food and Nutrition series, No.24. Food and Agriculture Organization, Rome.

FAO (2002). World Agriculture: Toward 2015/2030. Summary report. Food and Agriculture Organization, Rome.

FAO (Food and Agriculture Organization) (2004). Paper presentation in the FAO Conference, "Rice in Global Markets and Sustainable Production Systems". The International Year of Rice: Rome. *http://www.fao.org/rice2004/en/aboutrice.htm.* (Accessed on 14 January 2007).

Key Message 4

FAOSTAT (2009). Crops primary equivalent. *http://faostat.fao.org/site/609/default.aspx#ancor* (Accessed on 17 October 2008).

Fung TT, Hu FB, Pereira MA, Liu S, Stampfer MJ, Colditz GA & Willett WC (2002). Whole-grain intake and the risk of type 2 diabetes: a prospective study in men. *Am J Clin Nutr* 76:535-540.

Gerhardt AL & Gallo NB (1998). Full-fat rice bran and oat bran similarly reduce hypercholesterolemia in humans. Human Nutrition and Metabolism. *Am Soc Nutritional Sci* 128:865-869.

Goldberg G (2003). Edition: 2003. Plants: Diet and health. The report of the British Nutrition Foundation Task Force: Blackwell, Oxford.

Grasten SM, Juntunen KS, Poutanen KS, Gylling HK, Miettinen TA & Mykkanen HM (2000). Rye bread improves bowel function and decreases the concentrations of some compounds that are putative colon cancer risk markers in middle-aged women and men. Human nutrition and metabolism. *J Nutr* 130: 2215-2221.

Hanapi MJ (2008). The effects of consumption of high fibre rice on blood glucose control among patients with type 2 diabetes. Masters Thesis, Universiti Kebangsaan Malaysia.

Hanf V & Gonder U (2005). Nutrition and primary prevention of breast cancer: foods, nutrients and breast cancer risk. *Eur J Obstet Gynecol Reprod Biol* 123(2): 139-149.

Jacobs D, Pereira M, Slavin J & Marquart L (2000). Defining the impact of wholegrain intake on chronic disease. *Cereal Foods World* 45:51–53.

Jenkins DJA, Marchie A, Augustin LSA, Ros E & Kendall CWC (2004). Viscous dietary fibre and metabolic effects. *Clin Nutr (Suppl.)* 1(2): 39-49.

Kantor LS, Variyam JN, Allshouse JE, Putnam JJ & Lin BH (2001). Choose a variety of grains daily, especially whole rains: A challenge for consumers. The Dietary Guideline: Surveillance Issues and Research Needs. *Am Soc Nutritional Sci* 473-486.

Kasum CM, Nicodemus K, Harnack LJ, Jacobs DR & Folsom AR (2001). Whole grain intake and incident endometrial cancer: The Iowa Women's Health Study. *Nutr Cancer* 39:180–186.

Kasum CM, Jacobs DR, Nicodemus K & Folsom AR (2002). Dietary risk factors for upper aerodigestive tract cancers. *Int J Cancer* 99:267–272.

Key Message 4

Khor GL (1997). Nutrition and cardiovascular disease: an Asia Pacific perspective. *Asia Pac J Clin Nutr* 6(2):122-142.

Khusi LH, Meyer KA & Jacobs Jr DR (1999). Cereals, legumes, and chronic disease risk reduction: evidence from epidemiologic studies. *Am J Clin Nutr* 70: 451-458.

Lee S, Park H, Cho S, Jeong H, Hwang H & LeeY (2004). The supplementary effects of high dietary fibre rice (SUWON 464) on blood pressure and lipid metabolism in spontaneously hypertensive rats. Poster abstracts/Cardiovascular *pathology* 13: 80-138.

Leinonen K, Liukkonen K, Poutanen K, Uusitupa M & Mykkanen H (1999). Rye bread decreases postprandial insulin response but does not alter glucose response in healthy Finnish subjects. *Eur J Clin Nutr* 53: 262-267.

Leinonen K, Poutanen KS & Mykkanen HM (2000). Rye bread decreases serum total and LDL cholesterol in men with moderately elevated serum cholesterol. Human nutrition and metabolism. American Society for Nutritional Sciences. *J Nutr* 130:164-170

Ling WH, Wang LL & Ma J (2002). Supplementation of the black rice outer layer fraction to rabbits decreases atherosclerotic plaque formation and increases antioxidant status. Biochemical and molecular action of nutrients. *Am Soc Nutritional Sci* 132(1): 20-26.

Liu S (2003). Whole-grain foods, dietary fibre, and type 2 diabetes: searching for a kernel of truth. *Am J Clin Nutr* 77: 527-529.

Lovejoy JC, Most MM, Lefevre M, Greenway FL & Rood JC (2002). Effect of diets enriched in almonds on insulin action and serum lipids in adults with normal glucose tolerance or type 2 diabetes. *Am J Clin Nutr* 76(5): 1000-1006.

Maki KC, Davidson MH, Ingram KA, Veith PE, Bell M & Gugger E (2003). Lipid responses to consumption of a beta-glucan containing ready-to-eat cereal in children and adolescents with mild-to-moderate primary hypercholesterolemia. *Nutr Res* 23(11):1527-1535.

Marlett JA, McBurney MI & Slavin JL (2002). Position of the American Dietetic Association: health implications of dietary fibre. *J Am Diet Assoc* 102: 993–1000.

Marshall WE & Wadsworth JI (1994). Rice Science and Technology. CRC Press, USA.

Mazlan N, Horgan G & Stubbs RJ (2006). Energy density and weight of food effect short-term caloric compensation in men. *Physiol Behav* 87(4): 679-86.

McIntosh GH, Noakes M, Royle PJ & Foster PR (2003). Whole-grain rye and wheat foods and markers of bowel health in overweight middle-aged men. *Am J Clin Nutr* 77: 967-974.

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Meyer KA, Kushi LH, Jacobs Jr DR, Slavin J, Sellers TA & Folsom AR (2000). Carbohydrates, dietary fibre, and incident type 2 diabetes in older women. *Am J Clin Nutr* 71: 921- 930.

MOH (1985). Malaysian Food Act 1983 and Food Regulation 1985. Ministry of Health Malaysia, Putrajaya.

MOH (2006). Food Consumption Statistics of Malaysia 2003 for Adult Population Aged 18 to 59 Years. Ministry of Health Malaysia, Putrajaya.

Morgan LM, Tredger JA, Wright J & Marks V (1990). The effect of soluble and insoluble-fibre supplementation on post-prandial glucose tolerance, insulin and gastric inhibitory polypeptide secretion in healthy subjects. *Br J Nutr* 64: 103-110.

Morris J, Marr J & Clayton D (1977). Diet and heart: a postscript. *Br Med J* 2: 1307–1314.

NCCFN (National Coordinating Committee of Food and Nutrition) (1999). Malaysian Dietary Guidelines. Ministry of Health Malaysia, Kuala Lumpur.

Ng TKW (1997). Dietary fat and fibre intakes of malaysian adults: Issues and implications when 'Western Targets' are set as dietary goals. *Mal J Nutr* 3: 137-147.

Norimah AK, Safiah MY, Zuhaida H, Fatimah S, Rohida SH, Siti Haslinda MD & Siti Norazlin MN (2008). Habitual food intake of adults aged 18 to 59 years. A report of Malaysian Adult Nutrition Survey 2003. Volume 7. Nutrition Section, Family Health Development Division, Ministry of Health, Putrajaya.

Ohara I, Tabuchi R & Onai K (2000). Effects of modified rice bran on serum lipids and taste preference in streptozotocin-induced diabetic rats. *Nutr Res* 20(1): 59-68.

Panlasigui & Thompson (2006). Blood glucose lowering effects of brown rice in normal and diabetic subjects. *Int J Fd Sci Nutr* 57 (3-4):151-158.

Pereira MA, Jacobs DR, Slattery ML, Ruth KJ, Van Horn L, Hilner JE & Kushi LH (1998). The association of whole grain intake and fasting insulin in a biracial cohort of young adults: the CARDIA study. *CVD Prevention* 1: 231–242.

Pereira MA, Jacobs Jr DR, Pins JJ, Raatz SK, Gross MD, Slavin JL & Seaquist ER (2002). Effect of whole grains on insulin sensitivity in overweight hyperinsulinemic adults. *Am J Clin Nutr* 75: 848-855.

Key Message 4

Peter U, Sinha R & Chatterjee N (2003). Dietary fibre and colorectal adenoma in a colorectal cancer early detection programme. *Lancet* 361: 1491-1495.

Schulze MB, Schulz M, Heidemann C, Schienkiewitz A & Hoffmann K (2007). Fibre and magnesium intake and incidence of type 2 diabetes: A prospective study and meta-analysis. *Arch Intern Med* 167: 956–965.

Slavin JL, Martini MC, Jacobs DR Jr & Marquart L (1999). Plausible mechanisms for the protectiveness of whole grains. *Am J Clin Nutr* 70: 459–463.

Slavin J (2006). Beyond fibre: whole grains & health. In: Meskin M.S, Bidlack, W.R. & Randolph, R.K (ed). Phytochemicals: Nutrient-Gene Interaction. page 161-171. CRC press, USA.

Spiller GA, Story JA, Furumoto EJ, Chezem JC & Spiller M (2003). Effect of tartaric acid and dietary fibre from sun-dried raisins on colonic function and on bile acid and volatile fatty acid excretion in healthy adults. *Br J Nutr* 90: 803-807.

Suzana S, Azhar Y & Fatimah A (2004). Association between dietary fibre and cancer: a case-control study in Malaysia. *Mal J Nutr* 10(2): 173-182.

Terry P, Lagergren J, Ye W, Wolk A & Nyren O (2001). Inverse association between intake of cereal fibre and risk of gastric cardia cancer. *Gastroenterology* 120: 387–391.

Tovey FI & Hobsley M (2004). Milling of wheat, maize and rice: Effects on fibre and lipid content and health. *World J Gastroenterol* 10(12): 1695-1696.

Truswell AS (2002). Cereal grains and coronary heart disease. *Eur J Clin Nutr* 56: 1-14.

Turpeinen AM, Juntunen K, Mutanen M & Mykkanen H (2000). Similar responses in hemostatic factors after consumption of wholemeal rye bread and low-fibre wheat bread. *Eur J Clin* Nutr 54: 418-423.

van Dam RM, Willett WC, Rimm EB, Stampfer MJ & Hu FB (2002). Dietary fat and meat intake in relation to risk of type 2 diabetes in men. *Diabetes Care* 25(3): 417–424.

WCRF/AICR (2007). Food, nutrition, physical activity and the prevention of cancer: a global perspective. Chapter 4. Foods and Drinks. pp 66 - 196. World Cancer Research Fund/ American Institute of Cancer Research, Washington DC.

Weickert MO, Mohlig M, Koebnick C, Holst JJ & Namsolleck P (2005). Impact of cereal fibre on glucose-regulating factors. *Diabetologia* 8: 2343–2353.

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Weickert MO, Mohlig M, Schofl C, Arafat AM & Otto B (2006). Cereal fibre improves whole body insulin sensitivity in overweight and obese women. *Diabetes Care* 29: 775–780.

Yang EJ, Kerver JM, Park YK, Kayitsinga J, Allison DB & Song WO (2003). Carbohydrate intake and biomarkers of glycemic control among US adults: the third, National Health and Nutrition Examination Survey (NHANES III). *Am J Clin Nutr* 77 (6) : 1426 - 1433.