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EFFECT OF WHEAT MILLING BY PRODUCTS (BRAN) AND CELLULOSE ON CHOLESTEROL, LIPID PROFILE AND ATHEROGENIC FACTOR FOR GROWING RATS

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ABSTRACT

Cholesterol and lipid profile lowering effects of wheat milling by products (wheat bran) compared with cellulose in male Sprague Dawley growing rats was studied. Different levels of cellulose and wheat bran were formulated into seven balanced basal diets to provide 0, 5, 10 and 15 % of both cellulose and wheat bran and fed to rats for 4 weeks. Each diet was also incorporated with 0.2 % pure cholesterol. Results showed that addition of 10 % and more wheat bran significantly (P< 0.05) reduced serum and liver total cholesterol (TC) compared with cellulose. Addition any level of cellulose or wheat bran did not significantly (P<0.05) reduced TC in kidney, heart and spleen of the rats. Whereas, addition of 10 % and more wheat bran significantly (P<0.05) increased fecal TC compared with cellulose. Addition of 10 % and more or 5 % and more of each cellulose and wheat bran, respectively significantly (P<0.05) reduced serum total lipids (TL), whereas incorporated 10 % and more wheat bran in the diets significantly reduced liver TL compared with addition even 15 % of cellulose. There were no significant differences in TL in kidney, heart and spleen after incorporated cellulose and wheat bran in the diets of the rats. Results showed that increasing the levels of wheat bran in the diets of the rats to 10 % and more, significantly (P<0.05) increased the concentration of TL in the feces compared with cellulose. Incorporation of the diets of the rats with 5, 10 and 15 % of both cellulose and wheat bran did not significantly (P<0.05) reduced serum Low Density Lipoprotein cholesterol (LDL-c) or increased serum High Density Lipoprotein cholesterol (HDL-c). However, addition of cellulose and wheat bran insignificantly (P<0.05) reduced serum LDL-c/HDL-c and TC/HDL-c ratios or atherogenic factor. It was concluded that addition of wheat bran may be enhanced the cholesterol lowering effect and reduced the atherogenic factor for growing rats.

INTRODUCTION

It has been recommended that the world population increase their intake of dietary fibers from different sources. Fibers, plant materials resistant to hydrolysis by the enzymes of the mammalian digestive tract are important components of foods (Eastwood, 1984; Schneeman, 1986 and Van Horn, 1997). The dietary fibers concept suggests that there is a negative relationship between the dietary fiber intake of a community and the incidence of some gastrointestinal and heart diseases (Liu *et al.*, 1982; Schneeman, 1986; 1987a and b; Jenkins *et al.*, 2001;

Jensen *et al*., 2004 and Pereira *et al*., 2004). Dietary fibers induce a number of physiological effects, depending upon the physical and chemical properties of the individual sources. The effects include increased fecal bulk, reduced levels of plasma cholesterol, reduced glycemic responses to a meal, and unfortunately decreased nutrients availability (Schneeman, 1986 and 1987a and b; Kritchevsky, 1997 and Al-Zuhayri, 2000). ___________________________

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Moreover, diets containing wheat bran protect against cancers of colon or breast in rats, and may be beneficial in humans (Helsby *et al*., 2000).

Previous studies have shown that wheat germ or wheat bran induced a significant decrease in the liver cholesterol and triglycerides in rats (Schneeman *et al*., 1984) in hamsters (Kahlon *et al*., 1998) and lipemia in human (Cara *et al*., 1992). Human epidemiological studies (Liu *et al*., 1999 and Wolk *et al*., 1999) have consistently shown a beneficial effect of wheat fiber in reducing the risk of cardiovascular disease. However, Borel *et al*. (1990) found that wheat bran has no direct effect on the mucosal uptake process, whereas wheat germ might decrease the uptake of dietary cholesterol by an as yet unknown mechanism. Other studies have shown that serum lipoprotein might also be affected in rats (Vigne *et al*., 1987) and in human (Cara *et al*., 1992 and Vuksan *et al*., 1999). Meta-analyses have found that β-glucan as soluble fiber in oat reduced blood total cholesterol and LDL-cholesterol concentration (Brown *et al*., 1999). Moreover, Davy *et al*. (2002) showed that high fiber oat comparing with the wheat cereal produced lower concentrations of small, dense LDL cholesterol and LDL particle number without producing adverse changes in blood acylglycerol or HDL-cholesterol concentrations. However, incorporation of these kinds of fibers in bread and cookies or in orange juice could have adverse effects on hypocholesterolemic properties (Kerckhoffs *et al*., 2003).

Until nowadays, the study of physiological effects of fibers, especially those relating to the effect of wheat cereal products such as bran on blood cholesterol and lipids profile have given inconsistent and often contradictory results. Using animal models provide a suitable approach for comparing lipid-lowering effects of dietary fibers under controlled condition (Anderson and Hanna, 1999) and rats is a useful animals model for evaluating the effects of fibers on intestinal function, since rats and humans have similar segmented colonic musculature (Bing, 1976). For this reason, the present study was undertaken to evaluate the effect of different levels of wheat milling by product as crude fiber (bran) and commercial cellulose as a comparative pure component of total fibers on cholesterol and lipid profile of blood and endogenous organs of growing rats.

MATERIALS AND METHODS

Sources of fiber: Crude Wheat bran, wheat milling by product used in this experiment was extracted from whole wheat flour (Al-adnaynia wheat, *Triticum aestivum*) using sieve No 32 W or 0.666 mm. Pure cellulose was commercial product of Merchery Nagel & Co. D-516D-Uren, Germany. Moisture, ash, protein, lipid extract contents and fiber in bran were determined by AOAC methods (AOAC, 1980).

Table (1): The chemical composition of wheat milling products, bran (g/100 g).

Item	Wheat milling products %, Crude Wheat bran	Item	Wheat milling products %, Crude Wheat bran
Moisture	12.8	Ash	4.9
Protein	12	Total fiber Soluble fiber	34 (11.5)
Lipid extract	3.1	*carbohydrate	33.2

* By deference.

Diet preparation: Crude wheat bran and cellulose were added to a basal diet formulation to provide 0,5,10 and 15% fiber. Each diet contained 0.2% added cholesterol. The diets were formulated according to NAS-NRC (1978). The amount of dietary protein and fat were formulated to be similar in all diets by adjusting the level of protein (casein) and fat (Corn oil) added. Diet ingredients were thoroughly mixed in a mixer bowl by a mechanical mixer. The composition of the experimental diets is shown in Table 2.

Table (2): Composition of experimental diets (g/kg diet).

Ingredients	Dietary groups						
	0 % fiber	Cellulose			Wheat Bran, fiber		
		5 %	10 %	15 %	5 %	10 %	15 %
Crude wheat bran	0	0	0	0	147	294	441
Cellulose	0	50	100	150	0	0	0
Casein	143	143	143	143	122	101	80
Corn oil	100	100	100	100	95.5	91.2	86.3
Vitamins Mix.1	15	15	15	15	15	15	15
Minerals Mix.2	50	50	50	50	50	50	50
Glucose	100	100	100	100	100	100	100
Sucrose	100	100	100	100	100	100	100
Starch	492	442	392	345	370.5	248.8	127.7
Determined Fiber %	0	5	9.94	14.9	5.1	10.0	15.1
Determined Protein %	12.0	12.1	12.3	12.2	11.9	11.8	12.2
Determined Cholesterol %	0.21	0.196	0.194	0.20	0.20	0.21	0.197

1 The Vitamins mixture contained (G/kg): Vitamin A (retinyl acetate) 20 000 000 IU; Vitamin D_3 (calciferol)
5 000 000 IU; α- Tocopherol 4 000; Thiamine hydrochloride1.0; Riboflavin 4.0; Pyridoxal hydrochloridez
3.0; Niacin 10.0; Folic acid 0.5; Calcium pantothenate 5.0; Vitamin B_{12} 0.005; Choline hydrochloride 75;
Ascorbic acid 45; Biotin 0.02; Menadoine 1.25 and starch to make 1 kg mixture.
2 The Minerals mixture contained (g/kg): $FeSO_4.7H_2O$ 3.5; $CaCO_3$ 280; NaH_2PO_4 360; KCl 76; $ZnSO_4$ 0.2;
$MnSO_4.H2O$ 2.0; $CuSO_4$ 4.0; KI 0.08; $MgCO_3$ 28 and starch to make 1 kg mixture.

Experimental animals: forty nine growing male albino-Sprague Dawley derived rats (grown in Food Sciences and Biotechnology Department, nutrition Lab.) were individually housed in stainless steel cages having wires mesh bottoms and fronts in room maintained at 25-30 ºC, and light between 7:0 AM to 7:0 PM daily. Animals were randomly divided into seven groups and fed the diets for 28 days. Food and distilled water were provided *ad libitum.* The animals' body weight and food scrap were weighted , measured and feces was collected and weighted once a week. At the termination of the experiment the rats were decapitated and blood, liver, kidney, heart and spleen were taken from the animals.
Biochemical Analysis: The concentration of Total cholesterol (TC) in liver, kidney, heart, spleen, feces and diets was determined according to the procedure followed by Tietz (1987) which was a modification of the Liberman-Buchared reaction after a modified Folch extraction of lipids (Folch *et al*., 1957 and Plummer, 1978). The extracted lipid from the samples were weighed and dissolved in 10 ml chloroform and 1 ml was used for the reaction. Reference cholesterol was obtained from Sigma chemical Co. (St. Louis, MO,

USA). Total cholesterol concentration of serum was determined by special kits manufactured by Bio Merieux – France and according to the enzymatic method of Richmond (1973) in which cholesterol and cholesterol esters transformed to quinoneimine. The samples were read using spectrophotometer at wavelength 500 nM. The concentration of Total cholesterol was calculated according to the following equation:

$$\text{Total cholesterol conc. (mg/dl)} = \frac{\text{(A) Sample}}{\text{(S) Standard}} \times \text{Standard Conc. (200 mg/dl)}$$

Low Density lipoprotein cholesterol (LDL-c) and High Density Lipoprotein cholesterol (HDL-c) concentrations were determined according to the method of Friedewald *et al.* (1972) and Tietz (1987). Total lipid in serum was measured according to the method followed by Fring and Dunn (1970). However, total lipid as extracted lipid in liver, kidneys, heart, spleen and feces was determined according to the method of Folch *et al*. (1957).

Statistical Analysis: Data from the experiments were analyzed by one way analysis of Variance and performed with SAS (1989) to compare the effect of different kinds and percentage of fibers on cholesterol, total lipids and lipoproteins in serum and endogenous organs. Standard deviations were calculated by using Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

To discuss our results in this study we have to recall that the experiment was designed to determine the cholesterolemic and lipidemic effects of the wheat milling products, namely crude wheat bran. Wheat bran, the outermost tissues of the seed, is the outer coating of the epidermis seed coat forming about 14 percent of the kernel, and has a chemical structure dependent upon the type of wheat, the milling process and the extent to which the bran is cleaved from the endosperm and germ (Eastwood, 1984). It is collective wheat materials such as fine or shorts, coarse bran and may be some wheat germ that is remains after wheat flour extraction which is called dietary fiber (Alsaidy, 1983). Dietary fiber can be classified into soluble and insoluble fiber. Crude wheat bran provides mostly insoluble fiber, which is about 50 % fermentable and considerable soluble fiber which is associated with reducing blood cholesterol levels (Hands, 2000). Table 1 shows that this wheat products contained 12.8% moisture, 12 % protein, 3.1 lipids extract, 4.9 % ash and 34% total fiber. It has been noticed form the Table that soluble fiber account 11.5 % of the total fiber in the wheat bran. This value was slightly higher than some of the literatures. Kahlon *et al*. (1998) found that soluble fiber in wheat bran accounts 7.75% of the total dietary fiber, whereas Rieckhoff *et al*. (1999) found more comparable value (8.8%). Our results for fiber analysis are in line and may be comparable with those tabulated by Hands (2000) in which wheat bran, as crude commercially milled contains: 10% moisture, 15.7% protein, 4.3% fat, 42.3% fiber, 6.0% ash 64.3% CHO including the fiber and 0.2 TE α-tocopherol. Soluble fiber which is found in high percent compare with wheat in other cereals or vegetables such as oat, rye and barley, which is known to have cholesterol lowering effects because of its promotion of increased fecal excretion of bile acids, slower cholesterol and lipid absorption, and total or

partial degradation of dietary fiber by colonic bacteria to produce hydrogen, methane, carbon dioxide, water and short chain fatty acids (Guthrie and Picciano, 1995 and Kritchevsky, 1997). However, insoluble fiber which is found in high percent in wheat bran known to alter transit time, enhance gastric emptying or speed the movement of material through the gastrointestinal tract and interference with bulk phase diffusion (Eastwood, 1984; Guthrie and Picciano, 1995 and

Kritchevsky, 1997). Although both soluble and insoluble fibers are healthful, their mutual effects reflect the overall functions of total dietary fiber. High fiber diet contained equal amount of soluble and insoluble fiber above the level recommended by American Dietetic association (ADA) resulted in significant reduction in total cholesterol concentrations, triglyceride concentrations and very low density lipoprotein cholesterol concentrations in patients with type 2 diabetes (Chandalia *et al*., 2000).

The effects of different levels wheat milling products, compared with cellulose on total cholesterol in serum and endogenous organs for growing rats are shown in Table 3.

Table (3): Effect of different levels of cellulose and bran on total cholesterol in serum and
endogenous organs in growing rats.

Tissue or organ	Dietary groups						
	0 % fiber	Cellulose			Wheat Bran		
		5 %	10 %	15 %	5 %	10 %	15 %
Serum,mg/100ml	66.1 a	63.6 ab	62.0 ab	61.7 ab	61.9 ab	60.1 b	60.6 b
Liver,mg/1g	4.03 a	3.89 ab	3.85 ab	3.85 ab	3.86 ab	3.50 c	3.51 c
Kidney,mg/1g	2.69 a	2.54 a	2.56 a	2.50 ab	2.59 a	2.43 ab	2.44 ab
Heart,mg/1g	2.13 a	2.09 ab	1.95 ab	2.10 ab	2.01 ab	1.96 ab	1.91 ab
Spleen,mg/1g	2.97 a	2.90 a	2.93a	2.90 a	2.90 a	2.85 a	2.83 a
Feces,mg/1g	4.01 c	4.03 c	4.17 bc	4.17 bc	4.043 c	4.44 b	5.13 a

The same letters in the row indicated that there were no significant differences at P<0.05.
The numbers are average of seven values for seven animals.

The Table shows that rats fed fiber free diet (contains 0 % fiber) had the highest (66.1 mg/100g) total cholesterol as baseline for the control group. With increasing the level of cellulose in the diets from 0 to 5, 10 and 15% resulted in no significant (P<0.05) differences (respective values of 63.6, 62.0 and 61.7 mg/100g for the three levels of cellulose) in the total cholesterol. Similar value (61.9 mg/100g) was noticed for animals fed 5% wheat bran. However, increasing the level of the wheat bran in the diets to 10%, the total cholesterol was decreased significantly (P<0.05) to 60.1 mg/100g. Since there was almost no change in total cholesterol with incorporated more wheat bran (15%) in the diet. One of the aims of our study was also to scan the effect of incorporation of more fiber in the diets of the rats on the total cholesterol in some endogenous organs. Table 3 also shows the effect of levels of fibers on the total cholesterol in these. The value of total cholesterol in the liver (4.03 mg/100g) as baseline value for rats fed 0% fiber was lyslight decreased to insignificant (P<0.05) values (3.89 and 3.86 mg/100g) when other groups of animals fed two diets contain 5% of cellulose and wheat bran, respectively. Whereas, increasing the levels of both cellulose and wheat bran to10% the total cholesterol was decreased significantly (P<0.05) to 3.8 and 3.5

mg/100g, respectively. No more change was found with increasing the level of the two kinds of fiber to 15%. Results show that the lowest value (3.5 mg/100g) of total cholesterol
was shown in liver of animals fed 10 % wheat bran. Table 3 also shows the effect of the cellulose and wheat bran on the total cholesterol in kidneys. Results show that there was no significant ($P<0.05$) effect of adding both cellulose and wheat bran to the diets of the rats even with 5 % or more (10 and 15 %). However, addition of 10 % and more of wheat bran showed notable but insignificant ($P<0.05$) change in the value of total cholesterol. Results in the Table 3 show that there were no significant ($P<0.05$) differences between the values of baseline total cholesterol in the heart and spleen for animals fed fiber free diet as control and other groups fed 5, 10 and 15 % of both cellulose and wheat bran. The effect of cellulose and wheat bran on the total cholesterol excreted in the feces of the rats was shown in the Table 3. Results show that there was insignificant ($P<0.05$) slight increase in total cholesterol in the feces of the animals fed free fiber diet from the baseline value of 4.01 mg/100g to 4.17 mg/100g in the feces of animals fed 10 and 15 % of cellulose. The results also show that using 5 % of wheat bran in the diet of the rats did not significantly ($P<0.05$) increase total cholesterol in the feces. However, addition of 10 and 15 % wheat bran to the diets of the animals resulted in significant ($P<0.05$) increase of total cholesterol from 4.01 mg/100g for animal fed fiber free diet to 4.44 and 5.13 mg/100g for the animals fed 10 and 15 % wheat bran, respectively.

Many epidemiological studies have shown the beneficial effects of wheat fiber in reducing the risk of coronary heart disease (Chen and Anderson, 1979; Cara *et al.*, 1992; Liu *et al.*, 1999 and Jacobs *et al.*, 2000). While, many other studies of wheat bran concluded that there was slight or no effect on serum cholesterol and lipids (Jenkins et al., 1975; Truswell, 1995 and Kritchvsky, 1997) and others considered wheat bran as a lipid neutral control fiber in assessment of the hypercholesterolemic effect of other fibers (Rieckhoff *et al.*, 1999 and Vuksan *et al.*, 1999). Our results were in line with those stated that postprandial lipidemia in healthy adults was reduced by wheat fiber (Cara *et al.*, 1992). Vuksan *et al.* (1999) concluded that the product of amylolytic digestion of starch from wheat flakes, which is high in wheat fiber and protein, has a fecal bulking effect similar to that of wheat bran and may have a beneficial effect on serum lipids for human. Further, Jacobs *et al* (2000) concluded that fiber from whole grains, but not refined grains, is inversely associated with all cause mortality in older women. Recently, Jensen *et al.* (2004) reported a beneficial association of whole grain intake with coronary heart disease and suggested that the bran component of whole grains could be a key factor in this relation in men. Fiber in general helps to increase the rate at which food is passed through the digestive tract, which might also enhance the daily fecal loss of cholesterol and bile acids (Mayo, 1997). The plasma cholesterol-lowering effects are found especially in hypercholesterolemic human subjects or animals, and are connected directly or indirectly with the metabolism of bile acids and neutral sterols in the intestinal tract and liver (Dongowski *et al.*, 2003).The adsorption of materials such as bile acids to fiber may prevent or alter the degradation of bile acids by bacteria and the subsequent reabsorption from the colon. Moreover, fiber may thus alter the type and proportion of bile acids returning to the liver. Wheat bran binds bile acids in vitro but does not have an immediate effect on total bile acids excretion in humans (Eastwood,

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1984). Similar observation was also found by Earnest *et al.* (1999) in human; wheat bran has been shown to decrease fecal bile acid concentration, mainly by reducing toxic secondary bile acids. Although, precise mechanisms and the components responsible for the cholesterol lowering effects are still not completely defined (Kritchevsky, 1997).

Many studies in animals confirmed the beneficial effects of cereals bran especially wheat bran and cellulose in different ways and forms even by processing them such as that of Kahlon *et al.* (1998) in hamsters. They found that plasma and liver cholesterol and total liver lipids were significantly lower with low energy extruded wheat bran compared with unprocessed wheat bran. They also found that total liver cholesterol and liver cholesterol concentration were significantly lower with high energy extruded rice bran compared with the cellulose control group. Whereas, they stated that plasma cholesterol and total liver cholesterol values with low energy extruded wheat bran were similar to those with rice bran diets. Previously, in rats Normand *et al.* (1984) concluded that cholesterol excretion in the feces was influenced by both purified rice hemicellulose and Alphacel cellulose in the diets. They added that rice hemicellulose appeared to have a greater influence on increasing the water content of the feces than on the levels of excreted sterols and serum sterols. In comparison with other cereal bran, plasma total cholesterol was slightly (not significantly) decreased in hamsters fed barley grains, oat bran and oat bran concentrate and significantly lower in animals fed rye bran diet when compared with the wheat bran (Rieckhoff *et al.*, 1999). Similarly, there were no significant differences in total plasma cholesterol values among the hamsters fed rice bran, oat bran and cellulose+ soy protein with added vitamin E and cellulose diets (Kahlon *et al.*, 1999). In human, Addition of barley bran flour significantly decreased total serum cholesterol as did addition of barley oil compared with cellulose control group after 30 days of intervention (Lupton *et al.*, 1994). In general, Pereira *et al.* (2004) suggested that consumption of dietary fiber from cereals and fruits is inversely associated with coronary heart disease for men and women.

The mean values of total lipids in serum and endogenous organs of growing rats as affected by different levels of cellulose and wheat bran are shown in Table 4.

Table (4): Effect of different levels of cellulose and bran on total lipids in serum and
endogenous organs in growing rats.

Tissue or organ	Dietary groups						
	0 % fiber	Cellulose			Wheat Bran		
		5 %	10 %	15 %	5 %	10 %	15 %
Serum,mg/100ml	329 a	323 ab	320 b	320. b	321 b	313 c	312 c
Liver,mg/1g	68.9 a	66.4 ab	66.6 ab	65.0 abc	64.7 abc	62.3 bc	60.7c
Kidney,mg/1g	26.4 a	24.4 a	24.4 a	22.9 a	24.1 a	23.9 a	22.6 a
Heart,mg/1g	23.7 a	23.0 a	23.3 a	22.9 a	23.3 a	22.0 a	22.9 a
Spleen,mg/1g	11.86 a	11.71 a	11.57 a	11.14 a	11.71	10.57 a	10.57 a
Feces,mg/1g	191 d	193 cd	196 abcd	199 abc	194 bcd	202 ab	203 a

The same letters in the row indicated that there were no significant differences at P<0.05.
The numbers are average of seven values for seven animals.

As indicated from the Table that the total lipids in serum of rats fed fiber free diets was 329 mg/100ml. This value was reduced significantly (P<0.05) to 320 and 320 mg/100ml total lipids in the serum of rats fed 10 and 15 % wheat bran in the diets, respectively. It seems to that there was no change in the total lipids with incorporated more cellulose than 10 % in the diet. Significant (P<0.05) reduction in the total lipids (313 mg/100ml) was occurred when the level of wheat bran was increased to 10 % in the diet of the rats. However, no significantly (P<0.05) change in total lipids was noted by addition more wheat bran to the diet. Table 4 shows that the concentration of total lipids in liver of rats fed fiber free diet was 68.9 mg/g. The results indicated that there were no significant (P<0.05) reduction in the total lipids achieved (66.4, 66.6, and 65.0 mg/g) with increasing the levels of fiber in the diets to 5, 10 and even with 15 % cellulose. By using wheat bran as incorporated fiber in the diets, the reduction in total lipids was slightly achieved (62.3 and 60.7 mg/g) with increasing the levels to 10 % and more (15 %). The total lipids in the kidneys, heart and spleen of the rats fed cellulose and wheat bran are shown also in Table 4. Kidneys, heart and spleen of the animals fed fiber free diets contained respective values of 26.4, 23.7 and 11.86 mg/g tissues as baseline for the control group. Slight insignificant (P<0.05) reductions in total lipids in all three endogenous organs of the animals were achieved with increasing the incorporated cellulose and wheat bran in the diets. The Table also shows that with increasing the levels of cellulose and wheat bran in the diets of the animals, more total lipids in their feces was excreted. The animals fed diet contained 15 % wheat bran showed higher concentration of total lipids in their feces (203 mg/1g) when compared with those fed on baseline control animals (191 mg/1g).

It has been known that wheat bran was associated with a major triglycerides lowering effect in animals such as rats (Anderson and Hanna, 1999). They also reviewed that limited number of observations were appeared to lower serum triglycerides by corn bran in the same animals. Further, Mongeau *et al*. (1990) confirmed that total fat excretion was increased with the presence of wheat bran and vegetable fibers, although serum and HDl cholesterol were unchanged. Whereas, Rieckhoff *et al*. (1999) found that plasma total triglycerides were not significantly decreased in hamster fed oat fiber and bran, rye, barley grains and wheat bran. However, Jenkins *et al*. (2002) concluded that addition of wheat bran to foods did not improved conventional markers of glycemic control or risk factors for coronary heart disease in type 2 diabetes over 3 months. They expected that possibly longer studies are required to demonstrate the benefits of cereal fiber. They added that cereal fiber in the diet may be a marker for another component of whole grains such as germ or larger particle size that imparts health advantages or a healthy lifestyle. Furthermore, type of dietary fiber and digestibility of the diet components are also have special concern. Lipid excretion for rice bran diets was significantly higher and lipid digestibility significantly lower than in the cellulose, oat bran, corn bran and wheat bran groups, while values for lipid excretion in wheat bran groups were significantly higher and lipid digestibility significantly lower than those in the corn bran groups (Kahlon et al., 1998). Similarly Kayashita *et al*. (1997) suggested that the cholesterol-lowering effect of buckwheat protein was mediated by higher fecal excretion of neutral sterols and that lower digestibility of buckwheat protein was at least partially responsible for the effect. However, Ernst and Levy (1984) review that Excess

levels of lipids may occur because of a fault in metabolism which results in overproduction, faulty degradation or defective removal of one or more lipoproteins.

The effect of different levels of cellulose and wheat bran on serum LDL-c and HDL-c lipoproteins in growing rats was shown in Table 5. There were reduction in serum LDL-c and increasing in serum HDL-c with increasing the levels of incorporated both cellulose and wheat bran in the diets compared with fiber free diet of the rats. Since, these results described that both cellulose and wheat bran had slight insignificant ($P<0.05$) and probably negligible effects on both serum LDL-c and HDL-c. However, the LDL-c/HDL-c and TC/HDL-c ratios which epitomize the atherogenic factors of the using these kinds of fibers had a different image of the above results. In which addition of 5, 10 and 15 %

Table (5): Effect of different levels of cellulose and wheat bran on some lipoproteins in
serum in growing rats.

Components	Dietary groups						
	0 % fiber	Cellulose			Wheat Bran		
		5 %	10 %	15 %	5 %	10 %	15 %
LDL-c mg/100ml	22.60 a	22.45 a	22.13 a	22.23 a	22.44 a	21.37 a	21.43 a
HDL-c mg/100ml	12.04 a	12.17 a	12.19 a	12.20 a	12.34 a	13.03 a	13.02 a
LDL-c/HDL-c	1.89 a	1.95 a	1.83 a	1.84 a	1.83 a	1.65 a	1.66 a
TC/HDL-c	5.33 a	5.26 a	5.11 a	5.30 a	5.07 a	4.83 a	4.93 a

The same letters in the row indicated that there were no significant differences at $P<0.05$.
The numbers are average of seven values for seven animals.

of cellulose to the fiber free diet of the rats resulted in inconsistent change in the ratio of LDL-c/HDL-c (the ratio was changed from 1.89 for rats fed fiber free diet to 1.95, 11.83 and 1.84 for rats fed 5, 10 and 15 % added cellulose to the diets, respectively). Whereas, addition of bran to the diets of the rats resulted in notable reduction in the ratio of LDL-c/HDL-C. The ratio was varied from baseline 1.89 for rats fed control diet to 1.83, 1.65 and 1.66 for animals fed 5, 10 and 15 % added bran to the diets, respectively. Similar results were shown with the TC/HDL-c ratio.

The most important reasons for quantifying lipoproteins is to define an individual's risk for heart disease, because some lipoproteins have been directly associated with cardiovascular disease but others have not (Ernst and Levy, 1984). Among the involved lipoproteins, it has been known that high serum LDL levels have a strong association with coronary heart disease, whereas, high serum HDL levels have been inversely associated with risk of this disease, however this correlation is independent of other factors (Ernst and Levy, 1984; Brody, 1999 and Wells, 2004). Therefore, therapy and good health has been based on the goals of reducing the concentration of LDL-cholesterol and increasing that of HDL-cholesterol in the plasma (Brody, 1999). Similarly, the low LDL-c/HDL-C or TC/HDL-c ratios (antiatherogenic factor) may be considered beneficial in terms of a reduction in risk of atherosclerosis which associated with heart disease (Al-Rawashdah, 1997 and Al-Kubati, 2003). Despite the fact that some unknown exist about the precise mechanism mediating

lipoprotein changes, substantial evidence supports the role of fiber in which support the inverse relationship between dietary fiber and atherosclerotic cardiovascular disease

(Anderson and Hanna, 1999). Because LDL particles carry about 65% of the cholesterol in serum, changes in total serum cholesterol values largely follow changes in serum LDL cholesterol concentrations (Anderson and Hanna, 1999). Kahlon *et al*. (1998) found that rice bran diets resulted in significantly lower levels of total plasma cholesterol and very low density lipoprotein cholesterol compared with wheat bran and cellulose control hamsters group. Further, also in hamsters they found that LDL-c values were similar for rice, oat, corn and wheat bran compared with those of the cellulose control. They also found that LDL-c for animal fed low energy extruded wheat bran diet was lower than that in hamsters fed unextruded and high energy extruded wheat bran. Feeding the processed high fiber, high protein wheat product for human resulted in a reduction in the ratio of total to HDL cholesterol (Vuksan *et al*. (1999). The ratio of HDL to VLDL+LDL cholesterol was increased in hamster fed oat bran, oat bran concentrate, oat fiber concentrate, barley grains, rye bran and wheat bran (Rieckhoff *et al*., 1999). But the highest ratio was caused by oat bran concentrate diet, which was more than twice that of wheat bran. However, regarding to the cellulose control study Lupton *et al*. (1994) found that total serum cholesterol or LDL-c of the cellulose control hypercholesterolemic group did not decrease significantly over 30 days of intervention trial, whereas, LDL-c decreased 6.5% with addition of barley bran flour and 9.2 % with addition of barley. The increased HDL-c may occurred by transferred chylomicron cholesterol as a result of cholesterol accumulation in peripheral tissues (Grundy, 1983). Wheat bran is also a source of vitamins especially vitamin E or α-tocopherol as an antioxidant and (Hands, 2000 and Todd *et al*., 1999) and phytic acid (Al-Kubati, 2000). Evidence was found that increase the consumption of foods rich in antioxidant vitamins and fiber were beneficial for coronary heart disease risk and the general health of the population (Todd *et al*., 1999). Similarly, buckwheat hull extract was shown to be effective for protecting biological systems such as LDL against various oxidative stresses in vitro and in vivo in mice (Mukoda *et al*., 2001). Mayo (1997) reviewed that the oxidative modification of LDL is believed to play an important role in the development of atherosclerosis. Dietary antioxidants that protect LDL from oxidation may help to prevent atherosclerosis and coronary heart disease. Plasma LDL-c values and LDL-c/HDL-c ratio in hamsters fed cellulose with soy protein, rice bran and oat bran with vitamin E diets were significantly lower than those fed cellulose diet (kahlon *et al*. 1999). In human Vuksan *et al*. (1999) suggested a significant tendency for the wheat fiber supplement and protein to lower the ratio of total to HDL cholesterol. Kahlon *et al*. (1999) reviewed that vitamin E is believed to lower the risk of atherosclerosis due to its antioxidant properties which may prevent oxidation of LDL. Finally, it was possible to find out whether specific wheat bran fractions such as antioxidant vitamins, collective polysaccarides, phytic acid, protein or even wheat bran lipids differentially affected lipid profile and atherogenisity. In conclusion, this study confirms the concept of beneficial association of wheat milling by product or crude wheat bran intake with atherogenesis by enhancing the cholesterol lowering effect and the possibility of reduction of atherogenic factors.

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تأثير الناتج العرضي لطحن القمح (ألياف القمح) والسللوز في مستوى الكولسترول ومكونات اللبيدات وعامل تكوين الخثرة في الجرذان النامية

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الخلا صة

تم دراسة تأثير تناول ألياف القمح مقارنة مع ألياف السللوز على مستوى الكولسترول ومكونات اللبيدات في مصل وبعض الأعضاء الداخلية والبراز في ذكور الجرذان النامية نوع سبراكو داولي. تم تحضير أغذية موزونة من ألياف القمح والسللوز وبمستويات ٠ و٥ و١٠و ١٥ % ويحتوي كل غذاء على حوالي٢ ٠ % كولسترول. تم تغذية الجرذان لمدة أربع أسابيع. وكانت النتائج هي كما يلي: بينت النتائج أن إضافة ١٠ % و أكثر ألياف القمح خفض كولسترول مصل الدم والكبد معنويا(P<0.05) مقارنة بالسللوز. إضافة أي مستوى من السللوز وألياف القمح لم ينخفض الكولسترول الكلي في كل من الكلى والقلب والطحال لدى الجرذان النامية. بينما إضافة ١٠ % أو أكثر من ألياف القمح ازداد الكولسترول الكلي في البراز معنويا (P<0.05) مقارنة بالسللوز. وان إضافة ١٠ و أكثر أو ٥ % و أكثر من كل من ألياف السللوز وألياف القمح على التوالي خفض اللبيدات الكلية في مصل الدم معنويا (P<0.05) ، بينما إضافة ١٠ % و أكثر من ألياف القمح خفض اللبيدات الكلية في الكبد معنويا (P<0.05) مقارنة بإضافة ١٥ % من السللوز. لا يوجد اختلافات معنوية(P<0.05) في اللبيدات الكلية في الكلى والقلب والطحال بإضافة أي مستوى من ألياف السللوز وألياف القمح إلى أغذية الجرذان النامية.أيضا أشارت النتائج إلى زيادة مستويات ألياف القمح في غذاء الجرذان إلى ١٠ % و أكثر ازداد تركيز اللبيدات الكلية في البراز معنويا (P<0.05) مقارنة بالسللوز. إضافة ٥و ١٠ و١٥ % من كل من ألياف السللوز وألياف القمح لم يخفض معنويا (P<0.05) من اللبيدات منخفضة الكثافة (LDL-c) أو يزيد من اللبيدات العالية الكثافة (HDL-c) في مصل الدم. لكن إضافة ألياف السللوز و ألياف القمح خفض من عامل تكون الخثرة atherogenic factor وهي نسبة LDL-c/HDL-c وTC/HDL-c في مصل الدم بصورة غير معنوية (P<0.05). أمكن الاستنتاج بان إضافة ألياف القمح أكد تأثيرها الخافض للكولسترول وقلل عامل التخثر لدى الجرذان النامية

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