Journal of Food and Dairy Sciences

Journal homepage: www.jfds.mans.edu.eg
Available online at: www. jfds.journals.ekb.eg

Biological Evaluation of Hemicellulose and Carboxymethyl Cellulose in Hypercholesterolemic Rats

Salem, M. A.[1]; A. M. Sorour[2]* ; M. A. El-Bana[2] and M. E. A. El-Sayed[1]

[1] Food Sci. and Tech. Dept., Fac. of Agric. Tanta Univ., Egypt.
[2] Food Tech. Res. Inst., Agric. Res. Center, Giza, Egypt

ABSTRACT

This investigation was conducted to study the effect of feeding on hemicellulose extracted from wheat bran (HC.Wb) and carboxymethyl cellulose produced from sugar beet pulp (CMC.Sbp) at levels 30, 60 and 90% for cellulose in hypercholesterolemic (Hyper-C) rats. Results showed that, replacing hypercholesterolemic (Hyper-C) diet with HC.Wb and CMC.Sbp significantly reduced total cholesterol (T.C), total triglycerides (T.G), low density lipoproteins (LDL-C), very low density lipoproteins (v.LDL-C), while high density lipoproteins (HDL-C) increased .Furthermore, Hyper-C diet with (HC.Wb and CMC.Sbp at level of 90% for cellulose) replacement also recorded the best and closest of HDL-C to (control–ve).Also, ALT was Significantly increased hyper-C control group (G_2). Concentration of enzyme (ALT) value in Hyper-C rats in group (G_2) was 52.73 U/L, whilst group (G_1) (control-ve) were 30.46 U/L. Feeding on Hyper-C diet replaced with HC.Wb at levels 30,60 and 90% (G_3, G_4 and G_5) led to a more reduction in concentration value of (ALT) being 39.26, 36.88 and 35.73 U/L, respectively while feeding on a high cholesterol diet replaced with CMC.Sbp at levels 30,60 and 90% (G_6, G_7 and G_8) led to a more reduction in concentration value of (ALT) were 37.50 ,35.38and 34.30 U/L, respectively comparing with Hyper-C control group (G_2). Histopathological examination showed that feeding diets supplemented with HC.Wb and CMC.Sbp to hyper-C rats lowered the degree of liver lesions. So it can be suggested that, HC.Wb and CMC.Sbp have a clear effect in decreasing cholesterol concentration and may be beneficial for patients with liver and cholesterol diseases.

Keywords: hemicellulose, carboxymethyl cellulose, wheat bran, sugar beet pulp, Hypercholesterolemic

INTRODUCTION

Hypercholesterolemia is the leading cause of coronary heart disease, which is mainly cause of death all over the world. Several methods and factors have been used to treat hypercholesterolemia, including dietary fat restriction(Tůma *et al*., 2014).

Hypercholesterolemic (Hyper-C) rats showed a marked increase in serum total lipid, TC, LDL-C , albumin, uric acid , glucose, and reduces the antioxidant defense system and reduces also, the activities of catalase and superoxide dismutase and increases the content of lipid peroxide [Salem and Zaahkouk (2000)and Anila and Vijayalakshmi. (2003)]

The effect of dietary fiber (DF) for cholesterol deficiency is due to its ability to improve the secretion of bile acids and cholesterol. (DF) can be a potential component to lower cholesterol in food , providing the industry with an opportunity to develop new products from foods rich in fiber. (Chau *et al*., 2004)

Wheat bran (Wb) is main compound of cell wall plant and inclouded several ingredients have nutritional value, as phenolic compounds, proteins and dietary fiber. The major components of the bran are carbohydrates, especially hemicellulose and other dietary fiber compounds. (Hille and Schooneveld-Bergmans, 2004)

Kamal-Eldin *et al*. (2009) studied 2 commercial Wb samples. Thedietary fiber (DF) content in those brans being (40 - 53 %), and starch (9 - 25 %). About 55 % of DF in wheat bran was hemicellulose, while the rest was cellulose (9-12 %), β-glucan (2.2-2.6 %). and lignin (3-5 %)

Sugar beet pulp, by-product of the sugar industry, is a cellulose source mainly as the lignocellulosic fraction of SBP contains 22–30% cellulose (Wen *et al*., 1988).

Cellulose may be converted into beneficial derivatives by etherification (Olaru *et al*., 1998). Carboxymethylcellulose (CMC) is the most water-soluble cellulose derivative, with many applications in the food and cosmetics ,drug, detergents industry, etc. (Togrul and Arslan, 2003)

Hu and Yu. (2012) and Maemura *et al*. (2016) found that, rats which fed on diet contain hemicellulose showed decreases in TC, TG, LDL-C and v.LDL-C value but there was an increase in HDL-C.

Hemicellulose (HC) had several biological activities including adsorbing cholesterol and bile acid and serve as a potential 'functional food' that reduces the incidence of CVDs by reducing risk of type-2 diabetes, body weight and LDL-C levels and adsorbing bile acids. Bile acids, derived from cholesterol, are essential for digestion of fat in the small intestine (Hu *et al*., 2007 and Hu. and Yu ., 2012)

Cellulose derivatives increased the fecal fat, sterol, and bile acid excretions. More than ever, decreased the weight gain, fatty weight, total, v.LDL and LDL cholesterol, and hepatic lipids in rats which fed on hyper-C diet (Bartley *et al*. 2010 and Hung *et al*. 2012).so, The current investigation was designed to study the effect of hemicellulose extracted from wheat bran (HC.Wb) and carboxymethyl cellulose produced from sugar beet pulp (CMC.Sbp) on hyper-C rats.

* **Corresponding author.**
E-mail address: ahmedsorror900@yahoo.com
DOI: 10.21608/jfds.2019.67853

MATERIALS AND METHODS

Materials

Sugar beet pulp (Sbp) was obtained from Delta Sugar Company, Kafr El-Sheikh Governorate, Egypt, during (2017) harvest season and stored in deep freeze at -20°C until use.

Wheat bran (Wb) was purchased from Delta Middle and West Milling Company, Tanta, Egypt.

Chemicals: All chemicals used in current study were obtained from El-Gomhoria Company for Chemical and Drugs; Merk Company for Chemical and Biodiagnostica, Egypt.

Methods:

Preparation of agro-industrial by-products samples:

Wb was air dried at 40°C for 1 hr. While Sbp was air dried at 40°C for 16 hr. then ground into fine power and stored in the polyethylene bags in the deep freezer at -20°C until use.

Gross chemical composition of Wb and Sbp:

AOAC methods (2005) were used to determine moisture and crude fat , Crude protein and total ash content. The total carbohydrate content was calculated by difference.

Defatted wheat bran (D.wb) and sugar beet bulp(D.sbp) :

Extraction of oil from Wb and Sbp were Implemented using themethod described by AOAC (2005).

Removal of starch from defatted wheat bran and sugar beet pulp:-

Elimination of starch from D.wb and D.sbp described by (Zhou *et al*., 2010).

Removal of protein from destarched and defatted wheat bran and sugar beet pulp:-

Removal of protein from destarched and defatted Wb and Sbp were implemented using themethod (Chanput *et al*., 2009).

Extraction of cellulose from deprotein, destarched and defatted Sbp :

Extraction of cellulose from deprotein, destarched and defatted SBP was implemented using themethod (Adinugraha *et al*., 2005)

Synthesis of sodium carboxymethyl cellulose:-

Synthesis of sodium carboxymethyl cellulose from Sbp according to (Adinugraha *et al*., 2005).

Extraction of hemicelluloses

Extraction of hemicellulose from deprotein, destarched and defatted Wb according to Nur-Hazlilla *et al*. (2016)

Animal and experimental design:

A total of 56 male Albino rats, with average weight (153-155) gram were used for biological evaluation of Hyper-C diets. All animals were housed individual cages with screen bottoms and fed on a basal diet for 7 days, under laboratory condition. Rats had been given free access to food and water the 12-week trial period after acclimation period. All 56 rats were divided into two main groups; the first group (7 rats) was fed on basal diet and kept as a negative control (C-ve). The second group (49 rats) was fed on basal diet mixed with cholesterol at 2 % concentration for 4 weeks before feeding the tested sample supplemented diets for acculamation of hyper-C described in Table (A)as mentioned by Lanepeter and Person,(1971).. Hyper-C rats were divided into 7 groups and fed experimental diets for 7 weeks as following table:

Table A. Composition of various Hyper-C diets (g/Kg):

Groups / Ingredients	Gr_1	Gr_2	Gr_3	Gr_4	Gr_5	Gr_6	Gr_7	Gr_8
Corn starch	660.5	548.0	548.0	548.0	548.0	548.0	548.0	548.0
Casein	140	140	140	140	140	140	140	140
Corn oil	100	100	100	100	100	100	100	100
Cellulose	50	50	35	20	5	35	20	5
CMC.Sbp	-	-	15	30	45	-	-	-
HC.Wb	-	-	-	-	-	15	30	45
Mineralmixture	35	35	35	35	35	35	35	35
Vitaminmixture	10	10	10	10	10	10	10	10
Cholesterol	0	10	10	10	10	10	10	10
Beeftallow	0	100	100	100	100	100	100	100
Bilesalt	0	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Choline chloride	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
DL- Methionine	2	2	2	2	2	2	2	2

Gr1: Feeding on thebasal diet (-ve).
Gr 2: Feeding on Hypercholesterolemia diet (+ve).
Gr 3: Feeding on Hypercholesterolemiadiet replaced 30% Caroboxymethyl cellulose produced from sugarbeet pulp(CMC .SBP) for cellulose
Gr 4: Feeding on Hypercholesterolemiadiet replaced 60% Caroboxymethyl cellulose produced from sugarbeet pulp(CMC .SBP) for cellulos
Gr 5: Feeding on Hypercholesterolemiadiet replaced 90% Caroboxy methyl cellulose produced from sugar beetpulp(CMC .SBP) for cellulose
Gr 6: Feeding on Hypercholesterolemiadiet replaced 30% Hemicellulose extracted from wheat bran(HC.WB) for cellulose
Gr 7: Feeding on Hypercholesterolemiadiet replaced 60% Hemicellulose extracted from wheat bran(HC.WB) for cellulose
Gr 8: Feeding on Hypercholesterolemiadiet replaced 90% Hemicellulose extracted from wheat bran(HC.WB) for cellulose

Blood sampling:

Blood samples were taken from rats at final of the experiment as mentioned by (El-Khamissy ., 2005).

Collection of organs:

All rats were sacrificed and the organs (liver, kidney and heart) were separated by careful then weighed. The relative weight of the organs were calculated from the following equation:

Relative organ weight (R.w) = (Organ weight / $Final\ B.W$) × 100

The determination of body weight gain (B.WG) and food efficiency ratio (F.ER) according to the method of Chapman *et al.* (1959) using the following equation:

$$\mathbf{B.W.G\%} = \frac{Final\ B.W - Intial\ B.W}{Intial\ B.W}$$

$$\mathbf{F.ER\%} = \frac{Gain\ weigh(g)}{food\ consum(g)}$$

Lipid profile determination:

T.C, HDL-C, LDL-C, v.LDL-C and T.G were determined according to the methods of Richmond (1973, Uwajima *et al* (1984) and Friedwald *et al*.(1972) respectively.

Determination of kidneys functions:

Urea, Uric acid ,Creatinine concentrations in serum were determined according to Chaney and Marbach, (1962).,Trinder, (1969). and Fabiny and Ertingshausen , (1971) respectively.

Determination of liver enzymes :

Determination of aspartate and alanine amino transferase (AS.T and AL.T) activities were measured by Varley *et al* . (1980) and alkaline phosphatase enzymes (AL.P) according to King King, (1965).

Determination of Serum antioxidants:

Concentration of serum glutathione peroxidase (GP.X.), superoxide dismutase (SO.D) and catalase (CA.T) activity were described by Oyanatui (1984).

Determination of Glucose :

Glucose was measured according to Triender (1969)

Histopathological :

At final of the experiment, Tissues from liver and pancreas of the sacrificed rats were examined as described by(Yoon *et al.,* 2001).

Statistical analysis :

Data were analyzed according to Steel and Torrie (1980) procedures (Duncan's multiple range test DMRT).

RESULTS AND DISCUSSION

Gross chemical composition of wheat bran and sugar beet pulp:-

Chemical composition of Wb and Sbp are showed in Table (1). Data showed that Wb included protein, fiber, ash and carbohydrates were significantly higher thanthose of Sbp. These results agreement with Salem *et al* . (2018).Furthermore, the data in Table 1 showed that Sbp had a higher fiber, cellulose and silica content of 18.64, 45.88 and 10.20%, respectively. while, Wheat bran had higher percentage of hemicellulose 49.85%. High cellulose content is required to produce good quality cellulose derivatives. The results obtained are consistent with Ludueña *et al.* (2011) and Merali *et al.* (2015)

Effect of feeding on replacing hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on hyper-C rats.

(A) Feeding and growth parameters of hyper-C rats:

Data in table (2) indicated that, effect of HC.WB and CMC.SBP on feed intake (F.I), body weight gain % (BW.G) and feed efficiency ratio (FE.R) in hyper-C rats for 12 weeks.

Table 1. chemical composition of Wb and Sbp on dry weight basis.

Samples Component	Wheat bran	Sugar beet Pulp
Moisture	8.12^{b} ±0.22	8.75^{a}±0.14
Crude protein	10.30^{a} ±0.12	9.80^{b} ±0.13
Ether extract	6.90^{b} ±0.10	6.83 ^{a} ±0.15
Ash content	11.91^{a}±0.13	7.95^{b} ±0.16
Crude fiber	10.41^{d} ±0.11	18.64^{a} ±0.14
Carbohydrate*	60.48^{a} ±0.87	56.78 ^{b} ±0.74
Cellulose	14.45^{d} ±0.18	34.34^{a} ±0.25
Hemicellulose	49.85^{a} ±0.10	29.76 ^{b} ±0.14
Lignin	5.85^{c} ±0.11	8.52^{a}±0.19
Silica	0.18^{b} ±0.09	1.09^{a} ±0.05

Means are an average of three determinations± standard deviation(SD). In a column; means with the same letters are not significantly different at <0.05 Carbohydrate* were calculated by differences

Table 2. Effect of feeding on replacing hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on feeding and growth parameters of hyper-C rats.

Parameters Animal groups	Initial Weight (g)	Final weight (g)	Body weight Gain (B. W.G) g	Body weight Gain (B. W.G) %	Feed Intake (g)	Feed efficiency ratio (F.ER)
Gr$_1$	157.89^{a} ±0.92	189.26^{f}±1.19	31.37^{c} ±0.34	19.86	1145.0^{c} ±0.93	2.73^{g}±0.03
Gr$_2$	156.80^{a} ±1.33	260.30^{a} ±1.34	103.50^{a} ±0.97	66.00	1254.2^{a} ±4.89	8.25^{a}±0.09
Gr$_3$	157.73^{a} ±1.34	215.47^{b}±2.3	57.74^{b} ±2.96	36.60	1145.7^{c}±5.84	5.03^{c}±0.25
Gr$_4$	156.49^{a} ±0.96	209.93^{c}±0.81	53.44^{b} ±0.58	34.14	908.1^{g}±5.37	5.88^{b}±0.08
Gr$_5$	157.61^{a} ±0.98	202.80^{d}±1.88	45.19^{b} ±2.32	28.67	1063.9^{e} ±8.46	4.24^{d}±0.21
Gr$_6$	157.46^{a} ±0.64	214.80^{b}±2.64	57.34^{b} ±3.03	36.41	994.51^{f} ±4.22	5.76^{b}±0.31
Gr$_7$	157.50^{a} ±0.58	203.88^{d}±2.75	46.38^{b}±2.86	29.44	1188.0^{b} ±6.58	3.90^{e}±0.21
Gr$_8$	156.90^{a} ±1.02	196.83^{e}±1.51	39.93^{c} ±0.56	25.44	1131.2^{d} ±3.01	3.53^{f}±0.04

Means are an average of ten determinations± SD. In a column ;means with the same letters are not significantly different at <0.05.. Gr1, Gr2 … etc. were as in Table (A)

Results point out, the mean values of initial body weight of all examined rat groups after seven7 days of acclimation which feed on basal diet, were almost the identical and no significant difference($P \leq 0.05$). It was ranged between (156.49:157.89 g). While at final of period (12 weeks), final body weight of hyper-C rat in group2 (control +ve) was higher than the negative group (Gr1). Body weight gain of the other groups presented a significant reduction in comparing those of hyper-C rats in Group 2 (control +ve). observed with the results obtained by De Vries *et al.* (2015) who mentioned that, the mechanisms of dietary fiber can contribute to weight loss contain: delayed gAS.Tric emptying, decrease glucose diffusion and prohibition fat absorption Thus, improving intake of dietary soluble fiber may be an effective means to decrease ability of metabolism. Also, found that food intake and F.ER in all rats in groups showed a significant reduced compared with those of hyper-C rats in group2 (control+ve) .This Data are Similar with (Hung *et al.,* 2012 , Young *et al.,*2012 and Tůma *et al.,* 2014).

(B) Relative organs weight of hyper-C rats:

Liver, kidney and heart of rats which fed on basal diet and other treatments were weighted at final of experiment (12 weeks) and the ratio of each organ to final body weight of rats was calculated.

Data offered in Table (3) appeared that, the weight of liver in group 2(control +ve) had the highest weight being (6.59g) and relatively liver weight (2.65) among all examined groups. This may be due to the assemblage of fat in liver tissues, El-Sayed, (2013).

Table 3. Effect of feeding on substituting hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on the relative organs weight in hyper-C rats.

Animal groups	Liver (g)	Liver R.W.	Kidneys (g)	Kidneys R.W.	Heart (g)	Heart R.W.	Final body weight
Gr$_1$	5.01^{d}±0.12	2.64	1.44^{a}±0.09	0.76	0.73^{a}±0.09	0.38	189.26^{f}±1.19
Gr$_2$	6.59^{a}±0.17	2.53	1.50^{a}±0.10	0.57	0.82^{a} ±0.08	0.31	260.30^{a}±1.34
Gr$_3$	5.19^{bc}±0.09	2.40	1.48^{a}±0.10	0.67	0.76^{a}±0.07	0.35	215.47^{b}±2.3
Gr$_4$	5.11^{bcd}±0.08	2.43	1.46^{a}±0.08	0.96	0.77^{a}±0.05	0.36	209.93^{c}±0.81
Gr$_5$	5.19^{bc} ±0.11	2.56	1.45^{a}±0.10	0.71	0.72^{a} ±0.06	0.35	202.80^{d}±1.88
Gr$_6$	5.27^{b}±0.10	2.45	1.46^{a}±0.10	0.67	0.72^{a} ±0. 11	0.33	214.80^{b}±2.64
Gr$_7$	5.17^{bcd}±0.11	2.53	1.45^{a}±0.09	0.71	0.73^{a} ±0.07	0.35	203.88^{d}±2.75
Gr$_8$	5.07^{cd}±0.12	2.57	1.44^{a}±0.09	0.73	0.73^{a}±0. 07	0.37	196.83^{e}±1.51

Means are an average of three determinations± SD. In a column ;means with the same letters are not significantly different at <0.05.. Gr1, Gr2 … etc. were as in Table (A)

For the results in the same table, group 1 (control -ve) had the lowest value in liver weight and relatively liver weight. moreover, the liver weight of rats fed with replacement with HC.WB and CMC.SBP for cellulose in the diet after hyper-C were lower than those of (control +ve).

The results showed that, there were no significant difference in both of kidney and heart weights, of neither control - ve nor (control + ve) and all examined groups which feed on HC.WB for cellulose at levels (30, 60 and 90%) respectively for groups (Gr_3, Gr_4 and Gr_5) and CMC.SBP for cellulose at levels (30, 60 and 90%) respectively for groups (Gr_6, Gr_7 and Gr_8). These data is closest with (Wang *et al.*, 2014).

(c) serum lipids parameter :

Data presented in Table (4) showed that, total cholesterol content at final experiment for Group 1 (control - ve) was 132.25 mg/dl, whilst a total cholesterol content of Group 2 (control +ve) was 254.33 mg/dl. moreover, rat groups Gr_3, Gr_4 and Gr_5 which feeding on hyper-C diet substituted with HC.WB at levels 30,60 and 90% for cellulose showed values of 168.95, 157.28and 152.21 mg/dl respectively while, rat groups Gr_6, Gr_7 and Gr_8 which feeding on hyper-C diet substituted with CMC.SBP at levels 30,60and 90% for cellulose showed values of 165.47 ,175.00 and 150.20 mg/dl respectively.

Furthermore, hyper-C rats fed on HC.WB and CMC.SBP had a significantly difference at ($P \leq 0.05$) were decreased in serum cholesterol compared with diet Gr_2. The obtained data are consistent with (Bartlely *et al.*, 2010.; Hung *et al.*, 2012and Tong *et al*.,2014) They found that the effect of lowering cholesterol in water-soluble fiber is due to its ability to form a gel, a characeristic it shares with some soluble fibers, forms a viscous gel in the intestine, and acts as a physical barrier to absorption of cholesterol, bile acids, and glucose.

Also,results showed that total triglycerides (TG) for Group 1 (control -ve) was 117.78 mg /dl after 12weeks. Increased to 219.13 mg/dl in hyper-C rats which fed on hyper-C diet in (Gr_2) while, total triglycerides contents for Gr_3, Gr_4 and Gr_5 which fed on hyper-C diet in replacement with HC.WB (30,60 and 90%) showed values of 136.7 , 134.23 and 131.45 mg/dl respectively. While, the total triglycerides contents for Gr_6, Gr_7 and Gr_8 fed on hyper-C diet replacement with CMC.SBP (30, 60 and 90%) showed values of 137.22, 133.36 and 130.94 mg/dl respectively.

The data in the current table illustrated that, replacement of feeding hyper-C diet with HC.WB and CMC.SBP led to enhancement HDL-C.

In addition to, hyper-C diet with HC.WB and CMC.SBP replacement at 90%. as well as,, it was better and closer than HDL-C to group 1 (control-ve).These means were significantly different in comparing with those means listed in Group 2 (control +ve).

As shown in Table (4) the values of LDL-C from $Group_1$ (control -ve) was 43.88 mg/dl, whilst value of hyper-C $Group_2$ (control +ve) was 165.39 mg/dl. Furthermore, LDL-C of rats fed on hyper-C diet replacing with HC.WB at the ratio of 30, 60 and 90% (Gr_3, Gr_4 and Gr_5) being 82.40, 69.40and 62.29 mg/dl, respectively. Whilst, LDL-Cl of rats fed on hyper-C diet substitution with replacement with CMC.SBP at the ratio 30 ,60 and 90% (Gr_6, Gr_7 and Gr_8) being 76.03 ,65.51 and 57.63 mg/dl, respectively. (Nishima and Freedl and 1990). indicates that some soluble fibers have the ability to bind bile acids or cholesterol during the formation of micelles. Reducing the output in the cholesterol content of the liver cells regulates the next LDL receptor by increasing LDL cholesterol removal. In addition, mechanisms include inhibition of the synthesis of hepatic fatty acids by fermentation products as acetate, butter and propionate.

From obtained data in table (4), the mean values of v.LDL-C of (control -ve) being 23.61 mg/dl, whilst the value of Group 2 (control +ve) being 43.76 mg/dl. Meanwhile, , v.LDLC of rats which fed on hyper-C diet repacing with HC.WB 30, 60 and 90% groups(Gr_3, Gr_4 and Gr_5) were 27.33, 26.80 and 26.26 mg/dl, respectively. While, the v.LDL-C of rats fed on hyper-C diet replacing with CMC.SBP 30 ,60 and 90% (Gr_6, Gr_7 and Gr_8) being 27.40, 26.63 and 26.16 mg/dl, respectively.

It could be noticed that, hyper-C rats fed on diet replacing with HC.WB and CMC.SBP at the ratio of 30, 60 and 90% to basal diets had a significant decreased T.C., T.G., LDL-C and VLDL-C compared with hyper-C Group 2 (control +ve).But, these groups had high level HDL-C at ($P \leq 0.05$). The obtained data are consistent with (Maki *et al*.1999 .; Hung *et al*. 2012 .; El-Sayed 2013 .; Tuma *et al*.2014. and Gunness *et al.*2016).

The aforementioned table showed that, values of blood sugar level of $Group_1$ (control -ve) and hyper-C groups during experimental periods. Blood sugar levels of hyper-C groups were significantly higher than those of Group 1 (control -ve), also different levels of HC.WB and CMC.SBP for cellulose which may be led to cause a significant decrease in blood glucose level of hyper-C rat groups (Gr_3, Gr_4, Gr_5, Gr_6, $Gr_7$and Gr_8), in comparing with the Group 2 (control +ve) . This may be due to that hemicellulose has been shown to decrease the high blood sugar with (Ronis *et al.*, 2010 and Sarah and Luma, 2018).

Table 4. Effect of feeding on replacing hemicellulose and carboxymethyl cellulose extracted from WB and SBP for cellulose on hyper-C rats.

lipid profile Animal groups	T. Cholesterol mg/dl	Triglyceride mg/dl	HDL –C mg/dl	LDL - C mg/dl	vLDL – C mg/dl	Blood sugar (mg/dl)
Gr_1	132.25^{e}±1.8	117.78^{e}±0.95	64.74^{b}±0.50	43.88^{h}±1.52	23.61^{e}±0.20	104.87^{f}±1.20
Gr_2	254.33^{a}±2.99	219.13^{a}±0.90	45.17^{g}±0.56	165.39^{a}±2.74	43.76^{a}±0.15	161.9^{a}±1.27
Gr_3	168.95^{b}±1.87	136.7^{b}±0.62	59.21^{f}±0.60	82.40^{b}±1.58	27.33^{b}±0.11	122.95^{b}±1.17
Gr_4	157.28^{c}±1.85	134.23^{c}±1.07	61.07^{e}±0.65	69.40^{d}±1.50	26.80^{c}±0.20	118.84^{c}±1.25
Gr_5	152.21^{d}±2.14	131.45^{d}±1.24	63.65^{c}±0.64	62.29^{f}±1.70	26.26^{d}±0.25	114.23^{d}±1.50
Gr_6	165.47^{b}±1.64	137.22^{b}±1.06	62.04^{d}±0.75	76.03^{c}±1.33	27.40^{b}±0.20	121.90^{b}±1.15
Gr_7	157.00^{c}±1.94	133.36^{c}±1.34	64.85^{b}±0.65	65.51^{e}±1.49	26.63^{c}±0.25	114.90^{d}±1.15
Gr_8	150.20^{d}±2.13	130.94^{d}±0.89	66.40^{a}±0.61	57.63^{g}±1.80	26.16^{d}±0.15	108.87^{e}±1.30

Means are an average of three determinations± SD. In a column ;means with the same letters are not significantly different at <0.05..
Gr1, Gr2 … etc. were as in Table (A)

(D) Liver function activities(AL.T) , (AS.T) , (AL.P) :

The effect of feeding on HC.WB and CMC.SBP for cellulose at level of, alanine amino transferase (AL.T), aspartate aminotransferase (AS.T) and (AL.P) enzymes in serum of hyper-C rats during experiment showed in Table (5).

At the end of experiment ,The level of AL.T of the hyper-C (control +ve) increased significantly compared with $Group_1$ (control -ve) was 129.26±19.59 and 52.73 and 30.46 U/L respectively. Meanwhile, the feeding on hyper-C diets replacing with HC.WB (Gr_3, Gr_4 and Gr_5) led to a more lowering at level 30,60 and 90% were 39.26, 36.88 and 35.73 U/L, respectively ,

the same trend were found when replacement with CMC.SBP at the same ratio (Gr_6, Gr_7 and Gr_8) .

Regarding to the results of serum AS.T, high cholesterol diet caused significant increase ($P<0.05$) in the hyper-C (control +ve) was 73.26 U/L comparative to (control -ve) group1 was 52.37 U/L . Whilst, the feeding on hyper-C diets replacing with HC.WB for cellulose at 30,60 and 90% were 59.53, 58.35 and 55.39 U/L respectively for(Gr_3, Gr_4 and Gr_5) , Also, feeding on hyper-C diets replacing with CMC.SBP at 30,60and 90% were 58.50, 57.32 and 54.38 U/L respectively for (Gr_6 , Gr_7 and Gr_8). These data were in a line with Ha *et al.*, 2005 and Wang 2014.

From another side, Alkaline phosphatase levels (AL.P) of group$_1$(control -ve) was 95.70 U/L while, (ALP) levels of hyper-C (control +ve) group $_2$. was 134.37 U/L. Meanwhile, Hyper-C rats fed on HC.WB and CMC.SBP which replacing with 30, 60 and 90% for cellulose showed significant lowered comparing with hyper-C (control +ve) group $_2$. Results correspond with Nahla H. Aly (2012) and Houa *el al.*(2013).

Table 5. Effect of feeding on substituting hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on liver function activities (AL.T) , (AS.T) , (AL.P) in hypercholesterolemic rats.

Animal groups	AL.T(U/L)	AS.T(U/L)	AL.P(U/L)
Gr_1	30.46^{e}±1.15	52.37^{f}±1.12	95.70^{g}±1.15
Gr_2	52.73^{a}±1.15	73.26^{a}±1.25	134.37^{a}±1.65
Gr_3	39.26^{b}±1.20	59.53^{b}±1.10	113.02^{b}±1.45
Gr_4	36.88^{c}±1.21	58.35^{bc}±1.26	108.12^{c}±2.01
Gr_5	35.73^{cd}±1.41	55.39^{de}±1.21	99.93^{e}±1.49
Gr_6	37.50^{bc}±1.20	58.50^{bc}±1.05	110.27^{bc}±1.95
Gr_7	35.38^{cd}±1.05	57.34^{cd}±1.12	103.87^{d}±1.75
Gr_8	34.30^{d}±1.10	54.38^{e}±1.12	96.80^{f}±1.0

Means are an average of three determinations± SD.
In a column ;means with the same letters are not significantly different at <0.05.. Gr1, Gr2 … etc. were as in Table (A)

(E) kidney functions (urea, uric acid and creatinine):

Mean values of urea, uric acid and creatinine in blood of Group $_1$ (control -ve) ,hyper-C group $_2$ (control +ve) and all other groups which fed on hyper-C diet which replaced with HC.WB and CMC.SBP at 30,60 and 90% for cellulose at final of experimental are shown in Table (6).

Data showed that, urea content of hyper-C group 2(control +ve) was 52.52 mg/dl in blood, while hyper-C which fed on hyper-C diet which replaced with HC.WB at levels 30,60 and 90% for cellulose at groups (Gr_3, Gr_4 and Gr_5) were 40.56, 38.31and 36.51 mg/dl respectively whilst replacement with CMC.SBP at the ratio of 30,60and 90% for cellulose at groups (Gr_6, Gr_7 and Gr_8) were 38.96, 36.70 and 34.92 mg/dl respectively.

Data showed that, the urea level was reduced in rats fed on hyper-C diets replaced with HC.WB and CMC.SBP at 30,60 and 90% for cellulose (Gr3,Gr4,Gr5 , Gr_6, Gr_7 and Gr_8) compared to hyper-C group $_2$ (control +ve)

The obtained data in Table (6) showed that, uric acid levels was reduced in rats fed on hyper-C diets replacing with HC.WB and CMC.SBP at 30,60 and 90% for cellulose (Gr3,Gr4,Gr5 , Gr_6, Gr_7 and Gr_8) compared to hyper-C control group (Gr_2).

The obtained data's showed that, creatinine contents of Group 1 (control -ve) was 0.83 mg/dl after 12 weeks, the same table showed that creatinine contents of hyper-C Group 2 (control +ve). was 1.14 mg/dl. while, hyper-C rats fed on hyper-C diets(Gr_3, Gr_4 and Gr_5) fed on HC.WB at levels 30,60 and 90% were 0.99, 0.93and 0.93 mg/dl, respectively .Furthermore, hyper-C rats fed on hyper-C diets(Gr_6, Gr_7 and Gr_8) fed on CMC.SBP at 30,60 and 90% for cellulose were 0.89, 0.91 and 0.87mg/dl, respectively.

From the data in table (6) Illustrated that, hyper-C rats which fed on HC.WB and CMC.SBP at (30,60and 90%) for cellulose had significantly reduce levels of creatinine, uric acid and urea in sblood compared with those of hyper-C Group 2 (control +ve). ($P\leq0.05$). Whilst, Group 1 (control -ve) Which feed on the basal diet had a significantly reduced level of urea, uric acid and creatinine. These results were in agreement with (Karthika and Devi, 2016 and Nie *et al*., 2017).

Table 6. Effect of feeding on substituting hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on kidney function activities (Urea , Uric acid and Creatinine) in hyper-C rats.

Animal group	Urea mg/dl	Uric acid mg/dl	Creatinine mg/dl
Gr_1	29.27^{f}±1.20	1.76^{e}±0.225	0.83^{d}±0.051
Gr_2	52.52^{a}±0.92	4.62^{a}±0.034	1.14^{a}±0.136
Gr_3	40.56^{b}±0.52	3.21^{b}±0.320	0.99^{b}±0.011
Gr_4	38.31^{cd}±1.08	2.51^{cd}±0.273	0.93^{bcd}±0.010
Gr_5	36.51^{de}±1.02	2.21^{de}±0.275	0.89^{bcd}±0.045
Gr_6	38.96^{bc}±1.05	2.95^{bc}±0.229	0.98^{bc}±0.015
Gr_7	36.70^{de}±0.81	2.49^{cd}±0.337	0.91^{bcd}±0.026
Gr_8	34.92^{e}±1.10	1.90^{e}±0.295	0.87^{cd}±0.032

Means are an average of three determinations± SD.
In a column ;means with the same letters are not significantly different at <0.05.. Gr1, Gr2 … etc. were as in Table (A)

(F) Serum antioxidants (G.P.X), (SO.D) and (CA.T) enzymes:

Data shown in Table (7) indicated that, hyper-C rats had significantly decreased the values of glutathione peroxidase (G.P.X), superoxide dismutase (SO.D) and catalase (CA.T) antioxidant enzymes activity in compared with negative groups (Gr_1). The results in the same Table showed that, replacing of HC.WB and CMC.SBP at level 30,60and 90% in hyper-C diet improved levels of (GP.X), (SO.D) and (CA.T) antioxidant activity enzymes in compared with (control + ve). These results agreement with Nahla H. Aly (2012) .; Houa *el al.*(2013) and Sarah and Luma, (2018) . They have stated that dietary fiber may reduce the absorption of dietary fat and cholesterol as well as increase the antioxidant enzyme.

Table 7. Effect of feeding on substituting hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose on (GP.X), (SO.D) and (CA.T) enzymes in hypercholesterolemia rats.

Animal group	GP.X (u/ml)	Catalase(u/ml)	SO.D(u/ml)
Gr_1	23.96^{a}±0.56	39.89^{a}±0.87	81.00^{a}±1.0
Gr_2	13.12^{f}±0.15	22.24^{e}±0.87	62.86^{e}±0.41
Gr_3	15.33^{e}±0.14	31.63^{d}±1.14	74.56^{d}±0.51
Gr_4	16.38^{d}±0.25	35.13^{c}±0.99	79.00^{b}±0.87
Gr_5	17.42^{bc}±0.27	37.76^{b}±0.85	79.96^{ab}±0.35
Gr_6	15.38^{e}±0.33	34.48^{c}±1.05	75.23^{d}±0.70
Gr_7	16.90^{bc}±0.18	37.87^{b}±0.87	77.13^{c}±0.80
Gr_8	17.60^{b}±0.30	38.21^{ab}±1.2	80.56^{a}±1.02

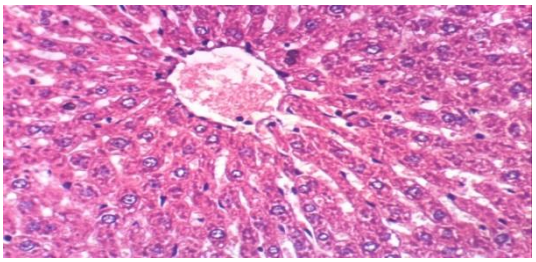
Means are an average of three determinations± SD.
In a column ;means with the same letters are not significantly different at <0.05.. Gr1, Gr2 … etc. were as in Table (A).

Histopathological changes:

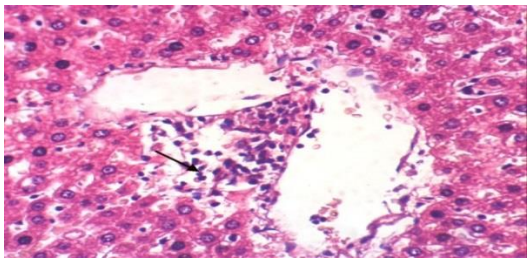
The influence of hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp on the liver, heart and kidney tissues of male albino rats were studied and the detected histopathological alterations were showed in table(8) and slides ,from NO.1 to NO.30 of the examined organs in various treatments.

Table 8. Histopsthalogical changes in liver, kidney and heart of rats fed on substituting hemicellulose and carboxymethyl cellulose extracted from Wb and Sbp for cellulose in hyper-C rats.

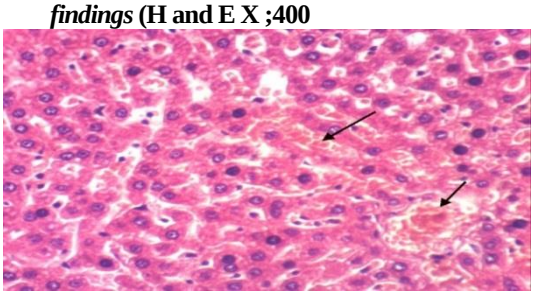
Animal group	Liver	Kideny	Heart
1	Normal	Normal	Normal
2	congestion of central vein and hepatic sinusoids, cytoplasmic vacuolizationof hepatocytes and focal hepatocellular necrosis associated with mononuclear inflammatory cells infiltration	congestion of renal blood vessel and proteinaceous material in the lumen of some renal tubules and showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration	showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration
3	cytoplasmic vacuolization of hepatocytes and dilatation of hepatic sinusoids	Normal	focal necrosis of cardiac myocytes associated with intermuscular oedema
4	Kupffer cells activation	Normal	Normal
5	Kupffer cells activation and portal infiltration with few inflammatory cells	Normal	Normal
6	Kupffer cells activation and portal infiltration with few inflammatory cells	Normal	showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration
7	Kupffer cells activation	Normal	Normal
8	Normal	Normal	Normal



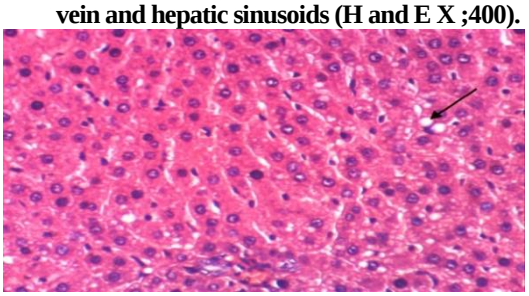
Slide 1. Liver of rat . Gr1 *showing normal histological findings* (H and E X ;400



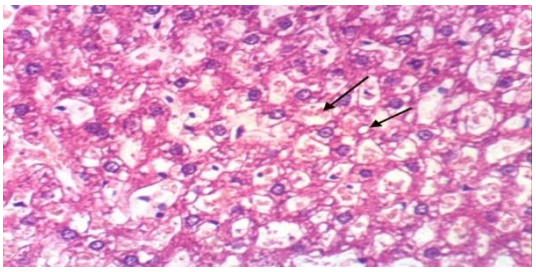
Slide 2. Liver of rat . Gr 2 showing congestion of central vein and hepatic sinusoids (H and E X ;400).



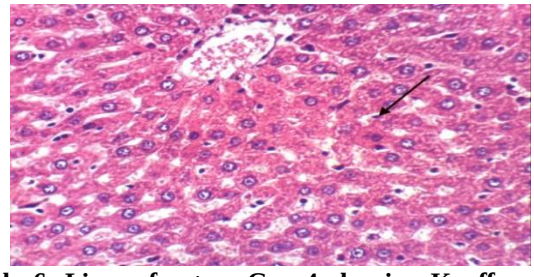
Slide 3. Liver of rat . Gr 2 showing cytoplasmic vacuolization of hepatocytes (H and E X ;400).



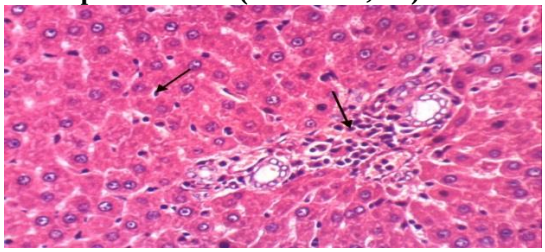
Slide 4. Liver of rat . Gr 2 showing focal hepatocellular necrosis associated with mononuclear inflammatory cells infiltration (H and E X ;400).



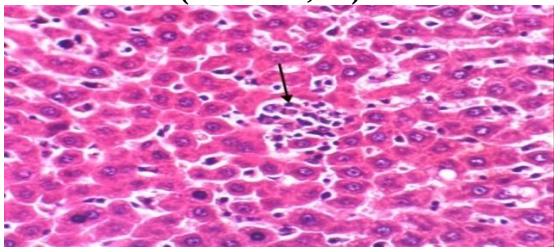
Slide 5. Liver of rat . Gr 3 showing cytoplasmic vacuolization of hepatocytes and dilatation of hepatic sinusoids (H and E X ;400).



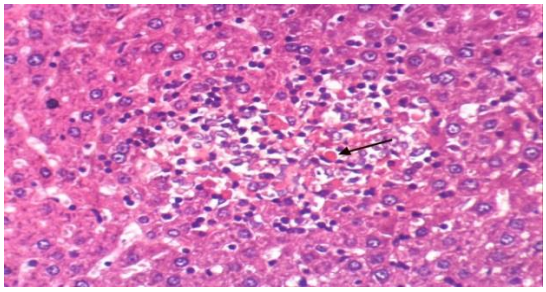
Slide 6. Liver of rat . Gr 4 showing Kupffer cells activation (H and E X ;400).



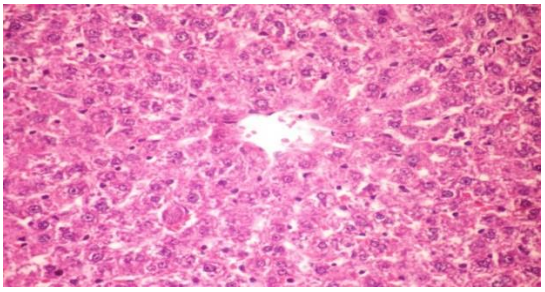
Slide 7. Liver of rat . Gr 5 showing Kupffer cells activation and portal infiltration with few inflammatory cells (H and E X ;400).



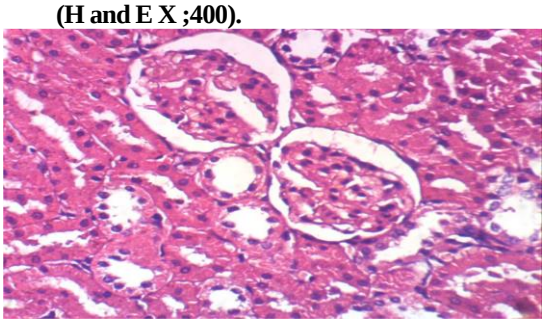
Slide 8. Liver of rat . Gr 6 showing Kupffer cells activation and portal infiltration with few inflammatory cells (H and E X ;400).



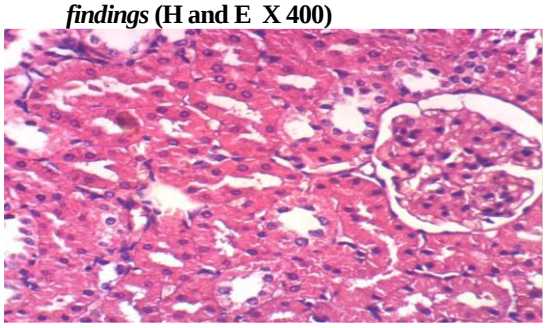
Slide 9. Liver of rat . Gr 7 showing Kupffer cells activation (H and E X ;400).



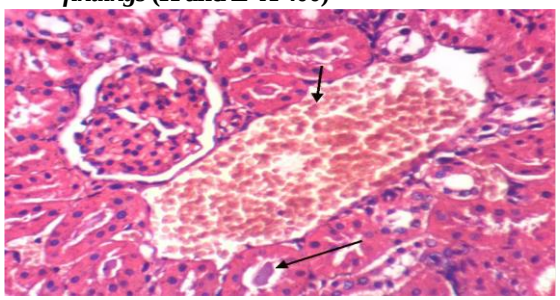
Slide10. liver of rat . Gr 8 *showing normal histological findings* (H and E X 400)



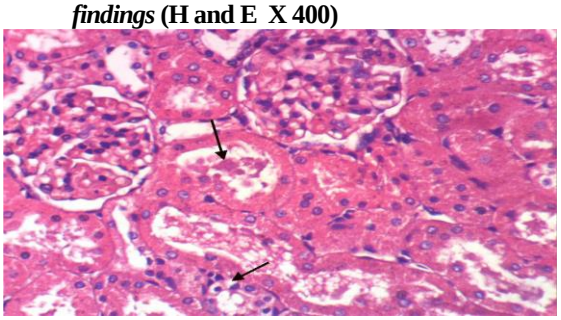
Slide 11. Kidney of rat . Gr 1 *showing normal histological findings* (H and E X 400)



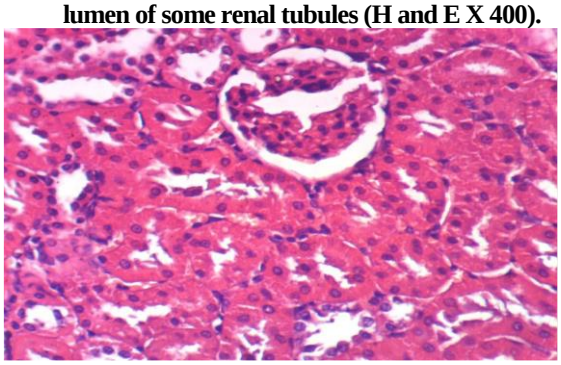
Slide 12. Kidney of rat . Gr 1 *showing normal histological findings* (H and E X 400)



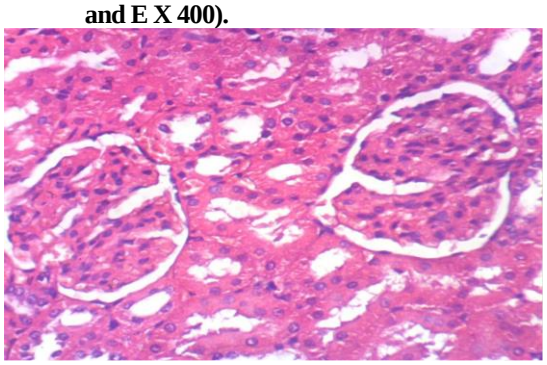
Slide 13. Kidney of rat . Gr 2 showing congestion of renal blood vessel and proteinaceous material in the lumen of some renal tubules (H and E X 400).



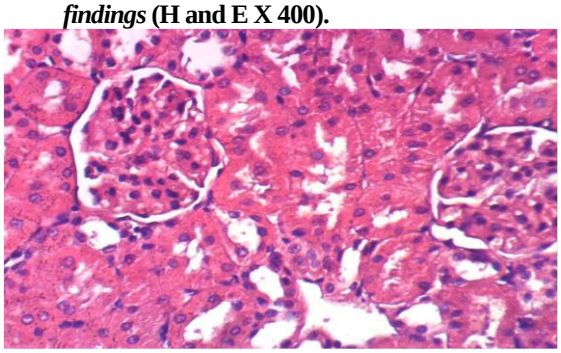
Slide. 14. Kidney of rat . Gr 2 showing proteinaceous material in the lumen of some renal tubules (H and E X 400).



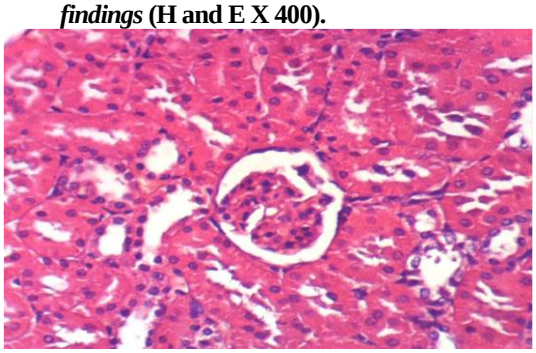
Slide 15. Kidney of rat . Gr 3 *showing normal histological findings* (H and E X 400).



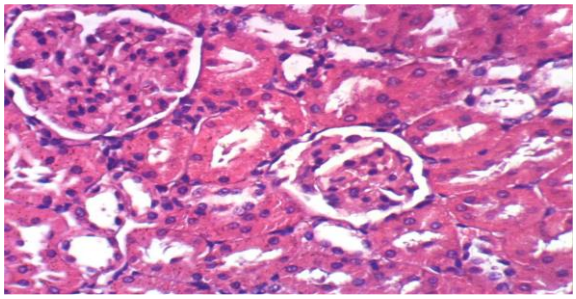
Slide 16. Kidney of rat . Gr 4 *showing normal histological findings* (H and E X 400).



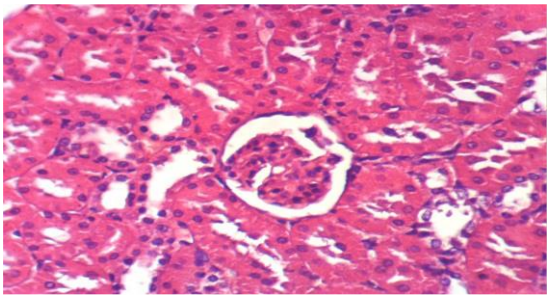
Slide 17. Kidney of rat . Gr 5 *showing normal histological findings* (H and E X 400)



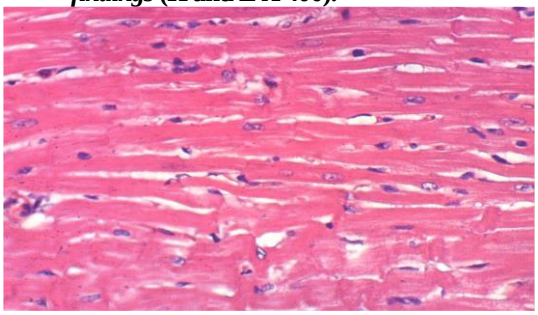
Slide 18. Kidney of rat . Gr 6 *showing normal histological findings* (H and E X 400)



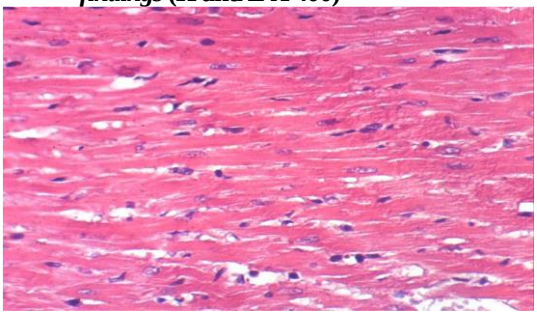
Slide 19. Kidney of rat . Gr *showing normal histological findings* (H and E X 400).



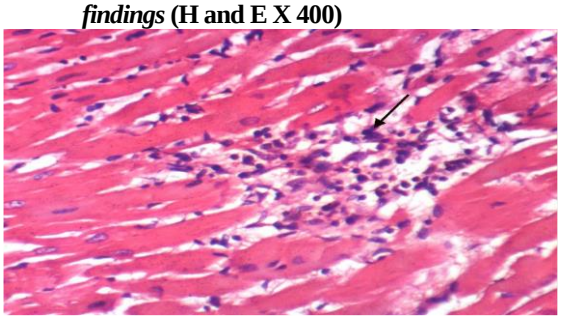
Slide 20. Kidney of rat. Gr 8 *showing normal histological findings* (H and E X 400)



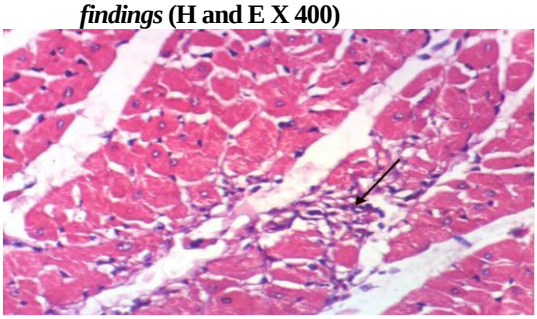
Slide 21. Heart of rat . Gr *showing normal histological findings* (H and E X 400)



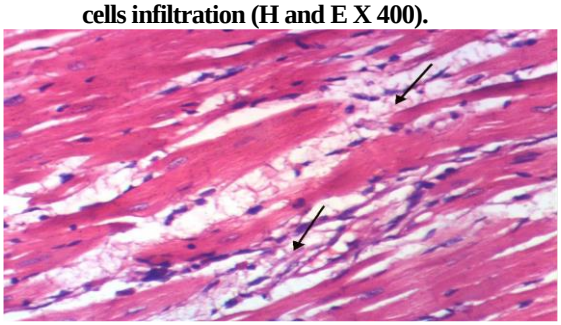
Slide 22. Heart of rat. Gr 1 *showing normal histological findings* (H and E X 400)



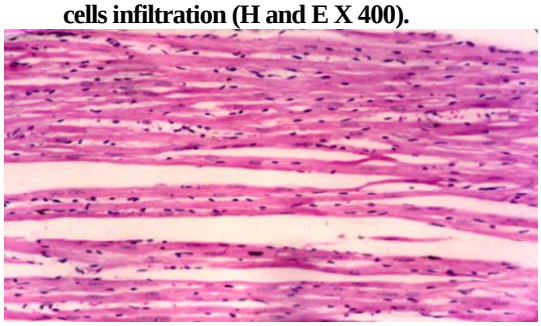
Slide 23. Heart of rat . Gr 2 showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration (H and E X 400).



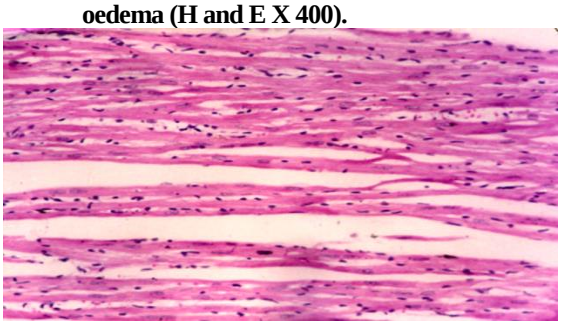
Slide 24. Heart of rat . Gr 2 showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration (H and E X 400).



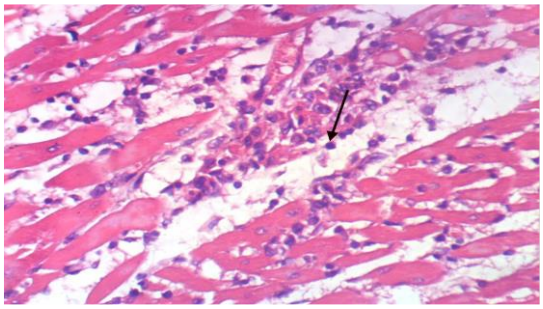
Slide 25. Heart of rat . Gr 3 showing focal necrosis of cardiac myocytes associated with intermuscular oedema (H and E X 400).



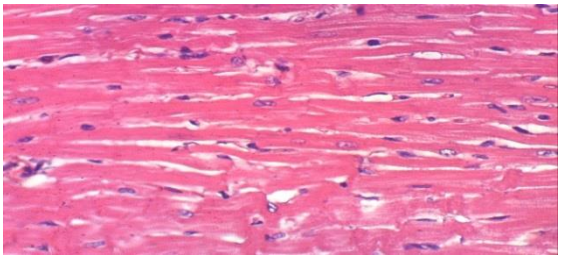
Slide 26. Heart of rat . Gr 4 *showing normal histological findings* (H and E X 400).



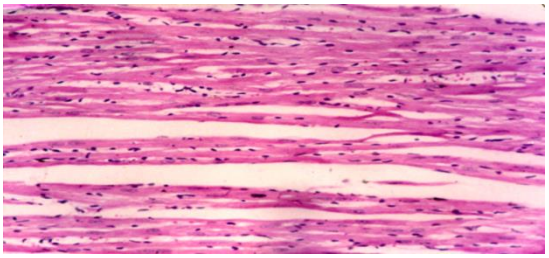
Slide 27. Heart of rat . Gr 5 showing *showing normal histological findings* (H and E X 400)



Slide 28. Heart of rat . Gr 6 showing focal necrosis of cardiac myocytes associated with inflammatory cells infiltration (H and E X 400)



Slide 29. Heart of rat . Gr 7 *showing normal histological findings* (H and E X 400)



Slide 30. Heart of rat . Gr 8 *showing normal histological findings* (H and E X 400).

REFERENCES

A.O.A.C., Association of Official Analytical Chemists 2005).Official Methods of Analysis of the Association of Official Analytical Chemists. 18th Ed. Washington, DC, USA.

Adinugraha, M. P.; Marseno, D. W. and Hayadi. (2005). Synthesis and haracterization of sodium carboxymethyl cellulose from cavendish banana pseudostem (*Musa cavendishii* LAMBERT). *Carbohydrate Polymer*, *62*, 164- 169.

Anila, L. and Vijayalakshmi, N.R. (2003). Antioxidant action of flavonoids from Mangifera indica and Emblica officinalis in hyper-C rats. Food Chem., 83: 569–574.

Bartley, G. E.; Yokoyama, W.; Young, S. A.;Anderson, W. K.;Hung, S. C.; Albers, D. R.; Langhorst , M. L. and Kim, H. (2010). Hypocholesterolemic effects of hydroxypropyl methylcellulose are mediated by altered gene expression in hepatic bile and cholesterol pathways of male hamsters, *J. Nutr*. 140(7), 1255-1260.

Chanput, W., Theeraulkait, C. and Nakai, S. (2009). Antioxidative properties of partially purified barley hordein, rice bran protein fractions and their hydrolysates. J. of Cereal Sci., 49: 422-429

Chapman, D. G.; CAS.Tilla, R. and Campbell, J. A. (1959). Evaluation of protein in food determination of protein and Feed efficiency ratio. Can. J. Biochem. and Physiol., 378:679-686.

Chau, C.F., Huang, Y.L. and Lin, C.Y. (2004). Investigation of the cholesterol-lowering action of insoluble fiber derived from the peel of Citrus sinensis L. cv. Liucheung. Food Chem ., 87:361– 366.

De Vries J.;Miller P.E. and Verbeke, K.(2015). Effects of cereal fiber on bowel function: A systematic review of intervention trials. World J. GAS.Troenterol.;21: 8952–8963.

El-Khamissy, A. (2005). Studies on Biological Effects of Some Diabetes Foods. Ph.D. Thesis, Dept. Hom. Economics Faculty of Specific Education, Tanta Univ.

El-Sayed, M. E. A.(2013) Effect of feeding on some dietary fibers for reducing blood cholesterol *J. Food and Dairy Sci., Mansoura Univ., Vol. 4 (1): 13 – 25*

Friedwald, W.T.; Levy, R.I. and Fredrickson, D.S. (1972). Estimation of the concentration of low-density lipoprotein separate by three different methods. Clin. Chem., 18: 499-502.

Gunness, P. Williams, B.A. Gerrits, W.J. Bird, A.R. Kravchuk, O., Gidley, M.J. (2016) Circulating triglycerides and bile acids are reduced by a soluble wheat arabinoxylan via modulation of bile concentration and lipid digestion rates in a pig model, Mol. Nutr. Food Res., 60(3) 642-51.

Ha, T. Y. ; Han, S. ; Kim, S. R. ; Kim, I. H. ; Lee, H. Y. and Kim, H. K. (2005). Bioactive components in rice bran oil improve lipid profiles in rats fed a high-cholesterol diet. Nutr. Res.,25: 597- 606.

Hille, J.D.R.; Schooneveld-Bergmans, M.E.F.(2004) Hemicellulases and their synergism in bread making. Cereal Foods World,.49: 283-286.

Houa, F. ; Zhanga, R. ;Zhanga, M. ;Zhencheng W. D. ; Denga, Y. ;Zhanga, Y. ; Chia, J. and Tanga, X. (2013). Hepatoprotective and antioxidant activity of anthocyanins in black rice bran on carbon tetrachloride-induced liver injury in mice. J. of Functional Foods., (5):1705-1713.

Hu, G., and Yu, W. (2012). Binding of cholesterol and bile acid to hemicelluloses from rice bran. International Journal of Food Sciences and Nutrition, 64(4), 461–

Hu, G.H.; Yang, F.; Ma, Z.Z. and Zhou Q. (2007). Development of research and application of rice bran dietary fiber. China Food Addit., 84(5):80–85

Hung, S. C.; Yokoyama, W.; Kim, H.; Bartley, G.; Andreson, W. H. K., Albers, D. R., Langhorst, M. L., Williams, D. M., Stott, W., Turowski, M., and Young, S. A. (2012). Effects of cationic hydroxyethyl cellulose on dyslipidemia in hamsters, *J. Agr. Food Chem.* 60(44), 11149-11156.

Karthika, D. and Devi, P.N. (2016). Hypolipidemic Effect of Rice Bran and Rice Bran Oil Incorporated Cookies. International J. Of Sci. Res., 5 (4) : 2277 - 8179

King, J. (1965). The phosphohydrolases acid and alkaline phosphatases. In: Practical and Clinical Enzymology, Eds., King, J. Van Nostrand Co. Ltd., London, pp: 191-208.

Lanepeter, W. and Person, A.E.G. (1971). Dietary require. In the laboratory animal principal and practice. Academic Press, London and New York.

Maemura, M.; Horiuchi, M.; Abe, T. and Kiwamu, S.(2016) . Preparation of bamboo hemicellulose hydrolysate possessing anti-oxidative properties and their effects on mice plasma cholesterol. Food Sci. and Tech. Res., 22 (4), 537-543.

Maes, C.and Delcour, J.A.(2002). Structural characterisation of water-extractable and water-unextractable arabinoxylans in wheat bran. J. of Cereal Sci., 35: 315–326

Maki, K. C., Davidson, M. H., Malik, K. C., Albrecht, H. H., O´Mullane, J., and Daggy, B. P. (1999). Cholesterol lowering with high-viscosity hydroxypropy lmethylcellulose, *Am. J. Cardiol.* 84(10), 1198-1203.

Nahla H. Aly (2012) Effect of dietary oat and wheat bran on biochemical changes in rats fed high fat-High Cholesterol Diets. J. of Applied Sciences Research, 8(1): 598-604

Nie, Y. ; Luo, F. ; Wang, L. ; Yang, T. ; Shi, L. ; Li, X. ; Shen, J. ; Xu, W. ; Guoa, T. and Lin, Q.(2017). Anti-hyperlipidemic effect of rice bran polysaccharide and its potential mechanism in high-fat diet mice. Food Funct., 8, 4028.

Nishima, P.M. and. Freedland, R.A. (1990) .The effects of dietary fiber feeding on cholesterol metabolism in rats, J. Nutr., 120:800–805.

Nur-Hazlilla, Z.; Sabiha-Hanim ,S.and Siti-Halimah, S.(2016) fractionation of hemicellulose from rice straw by alkaline extraction and ethanol precipitation. *.Malaysian J. of Anal. Sci., 20 (2): 329 – 334.*

Olaru, N.;Olaru, L.; Stoleriu, A. and Timpu, D. (1998). Carboxymethyl cellulose synthesis in organic media containing ethanol and/or acetone. J. of Applied Polymer Sci., 67, 481-486.

Oyanatui, Y.(1984). Reevaluation of essay methods and establishment of kit for superoxide dismutase activity. Anal. Bio.,142,290-296.

Richmond, W. (1973). Preparation and properties of cholesterol oxidase from Nocrdia spp. And its application to the enzymatic assay of total cholesterol in serum. Clin. Chem., 19: 1350-1356.

Ronis, M.J.; Badeaux J.; Chen Y. and Badger, T. M. (2010). Rice protein isolate improves lipid and glucose homeostasis in rats fed high fat/high cholesterol diets. Experimental Biology and Medicine., 235: 1102–1113.

Salem, M.M. and Zaahkouk, S.A. (2000): Effect of high fat and protein diet on some physiological parameters related to lipid and protein metabolism in albino rats. J. Egypt. Ger. Soc. Zool., 33: 279-290.

Sarah, M.A. and Luma, W.K. (2018). Protective role of soybean lecithin in reducing hypercholesterolemia and DNA fragmentation inducing by high cholesterol in adult male rats. Kufa Journal For Veterinary Medical Sciences , 9 (1):35-45.

Steel, R. G. and Torrie, J. H. (1980). Principles and Procedures of statistics. 2nd Ed. Mc-Graw-Hill,New York, USA, pp. 120-150.

Togrul, H., and Arslan, N. (2003). Production of carboxymethyl cellulose from sugar beet pulp cellulose and rheological behaviour of carboxymethyl cellulose. *Carbohydrate Polymers, 54*, 73–82.

Tong,L.T.; Zhong, K.; Liu,L.; Qiu, J.; Guo, L. ; Zhou,X.; Cao, L. and Zhou, S. (2014). Effects of dietary wheat bran arabinoxylans on cholesterol metabolism of hypercholesterolemic hamsters, Carbohydrate polymers 112: 1-5.

Trinder, P. (1969). Determination of glucose in blood using glucose oxidase with an alternative oxygen receptor, Ann. Clin. Biochem. 6, 24-27.

Tůma, J.; Volek, Z.; Synytsya, A.; Dušková, D. and Marounek, M. (2014). Hydrophobically modified celluloses as novel cholesterol-lowering polymers. BioResources 9(3), 4266-4273.

Uwajima ,T.; Shimizu, Y. and Terada O. (1984) Glycerol oxidase, a novel copper hemoprotein from Aspergillus japonicus. Molecular and catalytic properties of the enzyme and its application to the analysis of serum triglycerides. J. Biol. Chem., 259:2748–2753.

Varley, H., Gewenlok, A. and Bell, M.(1980).Practical Clinical Biochemistry . vol. 1. 5th Ed.,pp. 741-897. London: William Heinemen Medical.Books,Ltd.

Wang, C.; Li, D.; Xu, F.; Hao, T. and Zhang, T. (2014) . Comparison of two methods for the extraction of fractionated rice bran protein. J. of Chem., Article ID546345, 10 pages

Wen, L. F.; Chang, K. C.; Brown, G. and Gallaher, D. D. (1988). Isolation and Characterization of Hemicellulose and Cellulose from Sugar Beet Pulp. J. of Food Sci., 53(3), 826–829.

Yoon, B.I.; Choi, Y.K. ; Kim, D.Y. ; Hyun, B.H. ; Joo, K.H. ; Rim, H.J. and Lee, J.H. (2001). Infectivity and pathological changes in murine clonorchiasis: Comparison in immunocompetent and immunodeficient mice. J. Vet. Med. Sci., 63(4): 421-425.

Young, S. A.; Hung, S.-C.; Anderson, W. H. K.; Albers, D. R.; Langhorst, M. L.and Yokoyama, W.(2012). Effects of cationic hydroxyethyl cellulose on glucose metabolism and obesity in a diet-induced obesity mouse model. J. Diabetes . 4, 85–94.

Zhou, S.; Liu, X.; Guo, Y. Wang, Q.; Peng D. and Cao. L. (2010). Comparison of the immunological activities of arabinoxylans from wheat bran with alkali and xylanase-aid extraction. Carbohydrate Polymer 81: 784-789.

التقيم البيولوجى للهيمسيلولوز المستخرج من نخالة القمح و الكربوكسي ميثيل سيليلوز المنتج من لب بنجر السكر فى الفئران المصابه بالكليسترول

موسى عبده سالم[1] ، أحمد محمد عبدالرازق سرور[2]*، محمد أحمد البنا[2] و محمود امام عبدالعزيز السيد[1]

[1] قسم علوم و تكنولوجيا الأغذية كليه الزراعه جامعه طنطا

[2] معهد بحوث و تكنولوجيا الاغذية مركز البحوث الزراعية

أجرى هذا البحث لدراسه تأثير التغذية على الهيمسيلولوز المستخرج من نخالة القمح و الكربوكسي ميثيل سيليلوز المنتج من لب بنجر السكر بنسبة 30و60 و 90٪ للسليلوز في الفئران المصابه بالكوليسترول .أوضحت النتائج التي تم الحصول عليها أن استبدال نظام غذائي عالى الكوليسترول في الدم مع هيمسيلولوز مستخلص من نخالة القمح وكربوكسيل ميثيل السليلوز المنتج من لب بنجر السكر بنسبة 30و60 و 90٪ للسليلوز قلل بشكل كبير الكوليسترول الكلي في الدم ، الدهون الثلاثية الكلية ، البروتينات الدهنية منخفضة الكثافة ، البروتينات الدهنية منخفضة الكثافة للغاية ، بينما زيادة البروتينات الدهنية عالية الكثافة. وعلاوة على ذلك ، سجل نظام غذائي مفرط الكوليسترول مع استبدال (الهيمسيلولوز المستخرج من نخالة القمح والسليلوز كربوكسي ميثيل المنتج من لب بنجر السكر بنسبة 90 ٪ للسيلولوز) أفضل وأقرب البتائج بالمقارنه بمجموعه الكنترول. تم زيادة مستوي انزيمات الكبد(ALT) بشكل كبيرفى مجموعه الكنترول الإيجابية وكانت قيمة تركيز إنزيم (ALT)52.73 وحدة / لتر ، بينما كانت مجموعات الكنترول السلبية 30.46 وحدة / لتر .أدت التغذية مع استبدال الهيمسيلولوز المستخرج من نخالة القمح بنسبة 30،60 و 90 ٪ للسليلوز في مجموعات3 ، 4 و 5 أدت إلى مزيد من الانخفاض في قيمة التركيز منALT و كانت 39.26 ، 36.88 و 35.73 وحدة / لتر ، على التوالي في حين أن الاستبدال بكربوكسيل ميثيل سلولوز المنتج من لب بنجر السكر بنسبة 30،60 و 90٪ للسليلوز في المجموعات6 ، 7و 8 أدى إلى انخفاض أكثر في قيمة التركيز (ALT) كانت 37.50 ، 35.38 و 34.30 U / L ، على التوالي مقارنة مع مجموعة الكنترول الموجبه). أظهر الفحص النسيجي أن وجبات التغذية التى حدث بها استبدال بـالهيمسيلولوز المستخرج من نخالة القمح والسليلوز كربوكسي ميثيل المنتج من لب بنجر السكر للفئران المصابة بارتفاع الكوليسترول في الدم. قللت من درجة التلف الحادث للكبد. لذلك يمكن الإشارة إلى أن الهيمسيلولوز المستخرج من نخالة القمح والسليلوز كربوكسي ميثيل المنتج من لب بنجر السكر لهما تأثير واضح في خفض مستويات مصل الكوليسترول في الدم وقد يكون مفيدًا للمرضى الذين يعانون من أمراض الكبد والكوليسترول

الكلمات المفتاحية: هيمسيلولوز ، الكربوكسي ميثيل سليلوز ، رجيع الفمح لب ينجر السكر فرط كوليستيرول الدم