UTILIZATION OF FOOD PROCESSING WASTES AS SOURCES OF DIETARY FIBERS AND ITS EFFECT ON LIPOPROTEINS IN RATS.

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Abstract

Apple pomace , apricot and carrot peel were utilized as rich sources of dietary fibers as well as citrus pectin to study the role of dietary fibers and pectin to minimize of cholesterol and its derivatives , high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (vLDL) levels in experimental animals. Changes in liver function enzymes, glutamic oxaloacetate transaminase (GOT) and glutamic pyruvate transaminase (GPT) were also determined during the feeding period (50 days) . The animals were hyperholesterolamic through feeding on high fat diet. The obtained results reveal that feeding on high fat diets supplemented with10% fibers or 1% pectin increased food efficiency ratio, body weight gain and daily body weight . Therefore, increasing fibers content in diets raised nutritional parameters as well as growth rate in rats . Rats fed on diets supplemented with 5 and 10% of apricot or carrot increased organs weight especially, liver and kidney than those fed on all other test diets. Feeding on diets containing dietary fibers had long term effect on lowering total lipids, total cholesterol and triglycerides whereas , 0.5% citrus pectin had the greatest lowering effect followed by 10% apple pomace then 10% carrot and 5% apricot peel . Increasing fiber content in diet caused a decrease of liver cholesterol content. On the other hand, supplementing diet with 0.5% citrus pectin decreased liver cholesterol content greatly . High density lipoprotein level was highly significantly increased in rats fed on diet supplemented with 10% carrot peel followed by diets containing 5% apricot peel and 10% apple pomace while LDL.c and vLDL.c were reduced. The addition of 0.5% pectin to the high fat diet raised the HDL.c level approximately 37.90% and reduced greatly LDL.c and vLDT.c levels than those of rats fed on drug (Omega 3A) . Concerning liver function enzymes were reduced by fiber administration whereas, pectin had a positive effect in lowering the activities of serum transaminases (GOT and GPT) .

INTRODUCTION

Large amounts of solid wastes mainly, apple pomace, apricot and carrot peel are accumulated after extraction of juices from these fruits. These wastes , which represent about 40-50% of the original weight of fruits, are considered a great problem in the environment pollution which contain large amount of moisture, sugars, small amount of protein and have low pH values . These wastes are easily putrifiable and represent a main source of microbial contamination and cause serious disposal problems Gonzalez , *et al.* (1998) . The aforementioned wastes have higher contents of dietary fibers, so these wastes can be utilized as food supplement in certain food products . Dietary fibers and pectin are considered as very excellent hypocholesterolemic agents in animals . These components decreased serum total cholesterols, total lipids, low denisity lipoprotein cholesterol (LDLc) and reduce serum triglyceride, (SGPT) and (SGOT) as reported by Bobek *et al.* (1998); Bobek (1999); El-Zoghbi and Sitohy (2001) and Hanczakowski, *et al.* (2001). Recommendation of epidemiological and clinical studies support increase consumption of different sources of dietary fibers as part of strategy to protect human being from several disorders and reduce the risk of many diseases such as, diverticular diseases, heart diseases and diabetes Khalil, *et al.* (2002).

Therefore, this study was carried out to utilize some food processing wastes namely, apple pomace, apricot and carrot peel as sources of dietary fibers as well as citrus pectin and to study its effect on lipids metabolism in experimental animals .

MATERIALS AND METHODS

Materials :

Apple pomace was obtained from BEST Egyptian Canning Co., Minyet Samannud, Aga, Dakahlia Governorate, Egypt . Apricot peel was purchased from juice factory, Food Tech. Res. Institute, Agric. Res. Center, Giza, Egypt. Carrot roots and grapefruit fruits were obtained from an orchard near Kaluobia governorate, Egypt. Carrot peel was obtained after juice extraction by Brown juicer. Grapefruit peel was prepared after juice extraction and used for pectin extraction .

Peel used in this study were dried in an air circulated oven at 60°C for 12 hrs to moisture content 5-10% , milling using Moulinex mill machine then sieving through 21 mesh screen was accomplished .

Methods:

1- Chemical properties of fruit and vegetable wastes :

Moisture , ash , total dietary fiber, protein, cellulose, hemicellulose and lignin contents were determined according to the methods described in the A.O.A.C (1998).

Grapefruit peel pectin (High methoxyl) was extracted according to the method illustrated by Srirangarajan and Shrikhande (1977).

Kits of total lipids, total cholesterol , triglyceride, HDL.c, GOT and GPT enzymatic colorimetric determinations were obtained from Alkan Co., Egypt.

2-Biological evaluation

Experimental animals:

Adult male Albino rats (Sprague Dawley) weighing 120-160 gm, were obtained from the experimental animal house of Food Tech. Res. Institute, Agric. Res. Center, Giza, Egypt.

Experimental design :

Sixty six male albino rats were kept under normal healthy conditions and fed on basal diet (experimental diets for acclamization) for ten days. The composition of basal and high fat diets are given in Table (1). After feeding basal diet for ten days, rats were divided randomly into eleven groups (n= 6) according to the following scheme:-

G_1 -Rats fed o basal diet (Negative control) .

G_2 -Rats fed on high fat diet (Positive control)

G_3 -Rats fed on high fat diet +5% apple pomace

G_4 -Rats fed on high fat diet +10% apple pomace .

G_5 -Rats fed on high fat diet +5% apricot peel .

G_6 -Rats fed on high fat diet +10% apricot peel .

G_7 -Rats fed on high fat diet +5% carrot peel .

G_8 -Rats fed on high fat diet +10% carrot peel .

G_9 -Rats fed on high fat diet +0.5% pectin .

G_{10} -Rats fed on high fat diet +1% pectin .

G_{11}-Rats fed on high fat diet + Drug (Omega 3A) (Positive control) .

Drug : Omega 3 plus. Sedico Pharmaceutical Co. 6- O'ctober City, Egypt.

Dose : 25 mg/day/ rat.(Calculated according to RDA for hypercholesterolemic patient).

During the experiment period (50 days) rats were kept separately in well aerated cages (Stainless steel). The body weight was recorded every week and at the end of experiment, rats were fasted overnight and anesthesiaed using diethyl ether and blood samples were taken from hepatic portal veins, the orbital venous plexuses by capillary tube into a centrifuge tubes. Blood samples were centrifuged at 5000r.p.m for 15 min. to separate serum, then kept in plastic vials at – 20^{o}C until analysis within 0-24hrs . Liver, kidney , spleen , heart and lung were removed and weighed to calculate its relative ratio to final body weight, then kept in saline solution and stored at -20^{o}C until the determination of lipid parameters .

Table 1. Composition of basal and high fat diets (gm/100 gm).

Ingredients	Basal diet %	High fat diet %
Casein	12.00	12.00
Sunflower oil	5.00	-
Cellulose	4.00	4.00
Starch	73.80	57.55
*vitamins mixture	1.00	1.00
**Salt mixture	4.00	4.00
Choline chloride	0.20	0.20
Animal fat	-	20.00
Cholesterol	-	1.00
Bile salt	-	0.25

* Prepared according to Venkatarman *et al.* (1979).

** Prepared according to Hegsted *et al.* (1941).

3- <u>Biochemical analysis</u> :

- Serum total lipids were determined enzymatically according to the method described by Zollner and Kirsch (1962).

- The determination of total cholesterol in serum was performed following colorimeteric method of Allain *et al.* (1974).
- Triglyceride level was determined enzymatically according to the method described by Fossati and Prencipe (1982) .
- The determination of HDL- cholesterol in plasma was performed following colorimeteric method of Lopez *et al.* (1977) .

The determination of LDL-cholesterol and vLDL-cholesterol in serum were performed following the method of Lopez *et al.* (1977). Calculation of LDL and vLDL-cholesterol were carried out by the following equations :

vLDL-c (mg/dl) = Triglyceride/5

LDL-c (mg/dl) = Total cholesterol – (vLDL-c +HDL-c).

- Glutamic oxaloacetic transaminase (GOT) and glutamic pyruvate transaminase (GPT)were determined in serum samples using enzymatic colorimetric kits according to Reitman and Frankel (1957).
- The liver cholesterol was estimated by the method of Allain et al. (1974) .

Statistical analysis :

The data were subjected to statistical analysis using one way classification least significant differences L.S.D. according to Steel and Torrie (1980) . Significant differences were determined at the $p \leq 0.05$ level .

RESULTS AND DISCUSSION

Chemical properties of fruit and vegetable wastes .

Data in Table (2) show some chemical properties of some fruit and vegetable wastes namely apple pomace, apricot and carrot peel. The results indicate that moisture content ranged between 5.10% and 10.64%, protein content in apricot peel was higher than those of both apple pomace and carrot peel . Also, both apple pomace and apricot peel were similar in total dietary fiber content (16.05 and 16.02%, respectively). On the other hand, apricot peel had the highest level of cellulose (13.77%) followed by carrot peel and apple pomace which had the highest value of hemicellulose and lignin (13.62 and 12.33%, respectively).

Table 2. Chemical Composition of fruit and vegetable wastes .

Samples / *Components / %	Apple pomace	Apricot peel	Carrot peel
Moisture	8.54	10.64	5.10
Total ash	6.87	1.75	5.12
Insoluble ash	0.217	0.105	0.165
Protein	7.90	9.80	7.70
Total dietary fiber	16.05	16.02	10.57
Cellulose	6.48	13.77	10.96
Hemicellulose	13.62	3.60	6.87
Lignin	12.33	1.58	5.52

- On dry weight basis.

Influence of feeding on dietary fibers on growth rate and organs weight in rats .

Feeding and growth performance in terms of food intake (FI) food efficiency ratio (FER) and body weights (BW) of hypercholesterolamic rats fed on various diets containing different levels of dietary fibers are presented in Table (3). It could be noticed that, FI from hypercholesterolamic diet (G_2) recorded higher value than FI from basal diet (G_1) . Also, feeding on high fat diet supplemented with 5% apple pomace (G_3) and 5,10% apricot peel (G_5 and 6) lowered food intake by rats than that by rats fed on other diets . There is non significant difference in BW gain between all groups supplemented with the two levels of dietary fibers from apple pomace, apricot and carrot peel, whereas feeding on high fat and 5% apple pomace diet (G_3) had the lowest value of BW gain (6.0 gm) Table (3). Feeding on high fat diet supplemented with 0.5% pectin (G_9) reduced FER, final BW, BW gain and daily BW increase than (G_{10}) which containing 1% pectin . Therefore, supplementation with high level of dietary fibers (10%) increased greatly the daily BW compared with 5% fiber except for (G_8) which contained 10% carrot peel lowered daily BW than 5% (1.48 and 1.60%, respectively). Both of high fat diet (G_2) and high fat diet containing drug (G_{11}) decreased daily BW (- 0.725 and -0.14% , respectively) but the reduction was not significant . From these results it could be concluded that, the supplementation of high fat diets with 10% dietary fibers or 1% pectin increases

FER, BW gain and daily BW. This means that, increasing dietary fibers content raised the nutritional parameters as well as growth rate in rats.

Table 3. Nutritional parameters of rats fed on different levels of dietary fibers .

Treatments	Food intake (gm)	F.E.R. %	Initial B.W. (gm)	Final B.W. (gm)	B.W.gain (gm)	Daily B.W. increase %
G1	CDE 506.0 ± 36.1	CD 7.57 ± 1.5	CDE 132.0 ± 9.4	BC 170.3 ± 13.7	BC 38.3 ± 7.8	BC 0. 835 ± 0.17
G2	ABCDE 529.0 ± 19.0	DE 6.27 ± 1.2	ABCDE 138.0 ± 5.0	D 104.8 ± 5.2	BC 33.3 ± 7.4	E -0.725 ± 0.16
G3	E 461.9 ± 8.1	E 1.30 ± 0.03	E 120.5 ± 2.1	D 120.5 ± 6.4	C 6.0 ± 00	CD 0.130 ± 00
G4	ABC 573.1 ± 13.6	AB 14.12 ± 1.1	ABC 149.5 ± 3.5	A 230.5 ± 12.0	A 81.0 ± 8.5	A 1.76 ± 0.18
G5	DE 474.4 ± 4.8	A 18.69 ± 4.9	DE 123.8 ± 1.3	AB 212.3 ± 21.7	A 88.5 ± 22.6	A 1.92 ± 0.49
G6	DE 477.9 ± 26.1	A 19.02 ± 4.4	DE 124.7 ± 6.8	AB 215.321.4	A 90.7 ± 20.7	A 1.97 ± 0.45
G7	AB 598.0 ± 97.2	BC 12.10 ± 3.7	AB 156.0 ± 25.4	A 229.7 ± 53.0	A 73.7 ± 31.2	A 1.60 ± 0.67
G8	ABCD 554.9 ± 21.3	AB 14.29 ± 3.8	ABCD 144.8 ± 5.6	A 224.5 ± 28.0	A 79.8 ± 23.4	AB 1.48 ± 0.48
G9	A 610.8 ± 71.1	DE 2.38 ± 0.5	A 159.3 ± 18.6	CD 145.0 ± 19.5	BC 14.3 ± 2.5	CD 0.14 ± 0.35
G10	BCDE 520.1 ± 58.0	CD 7.60 ± 3.0	BCDE 135.7 ± 15.1	BC 176.3 ± 35.7	B 40.7 ± 20.6	B 0.88 ± 0.45
G11	ABC 577.5 ± 39.9	DE 2.54 ± 0.47	ABC 150.7 ± 10.4	CD 144.0 ± 20.7	BC 14.7 ± 3.1	DE -0.14 ± 0.35
P >	0.00026	0.0001	0.0026	0.0001	0.0001	0.0001

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

The effect of feeding on different levels of dietary fibers on organs weight of rats such as , liver , kidney , spleen and heart are shown in Table (4). The ratio between organ weight to its body weight was also calculated . As shown in Table (4), there is a significant difference in relative liver weights among groups . Results in the same table reveal that, rats fed on HFD (G_2) had significant lower weights in both liver and kidney than the control group fed on basal diet (G_1) , Rats fed on diets supplemented with 5 and 10% of both apricot and carrot peel (G_5 , 6, 7 and 8) increased organs weight especially, liver and kidney than those of rats fed on all other diets. The obtained results are in agreement with those obtained by Mahmoud (2001) , who reported that feeding of rats on 2% dried carrot and apricot as sources

of carotene (Provitamin A) increased the organs weight of experimental rats . From the same table, feeding on diets containing (0.5 and 1%) pectin decreased organs weight compared to other diets except for diets supplemented with apple pomace (G_3 and G_4) which gave the aforementioned effect on organs weight . It is clear that, apple pomace is a good source of pectin and the influence of pectin on organs weight may be attributed to the decrease in the diet palatability of rats .

Table 4. Influence of dietary fibers on organs weight of rats.

Treatments	Liver (gm)	Ratio %	Kidney (gm)	Ratio %	Spleen (gm)	Ratio %	Heart (gm)	Ratio %
G_1	BC 6.55 ± 0.75	3.76 ± 0.11	A 2.01 ± 0.30	1.18 ± 0.27	AB 0.84 ± 0.12	0.49 ± 0.11	BCD 0.69 ± 0.01	0.4 ± 0.03
G_2	C 3.89 ± 0.3	3.71 ± 0.48	B 1.04 ± 0.07	0.99 ± 0.12	BC 0.49 ± 0.09	0.46 ± 0.06	EF 0.43 ± 0.01	0.41 ± 0.03
G_3	C 4.13 ± 1.14	3.53 ± 0. 95	AB 1.26 ± 0.53	1.07 ± 0.44	C 0.40 ± 0.11	0.34 ± 0.09	DEF 0.48 ± 0.13	0.41 ± 0.11
G_4	BC 4.96 ± 0.19	3.53 ± 0.21	AB 1.53 ± 0.38	0.81 ± 0.29	BC 0.54 ± 0.07	0.28 ± 0.07	EF 0.44 ± 0.04	0.23 ± 0.01
G_5	A 9.72 ± 0.28	5.03 ± 0.14	A 1.97 ± 0.29	1.02 ± 0.15	AB 0.84 ± 0.12	0.43 ± 0.06	AB 0.85 ± 0.06	0.45 ± 0.04
G_6	A 10.02 ± 1.31	4.50 ± 0.23	AB 1.63 ± 0.00	0.74 ± 0.06	A 0.99 ± 0.09	0.46 ± 0.08	A 0.99 ± 0.10	0.45 ± 0.08
G_7	A 10.12 ± 1.52	4.49 ± 0.38	A 1.95 ± 0.02	0.89 ± 0.20	A 1.00 ± 0.20	0.48 ± 0.20	CDE 0.60 ± 0.08	0.28 ± 0.10
G_8	AB 7.58 ± 0.63	3.40 ± 0.60	AB 1.41 ± 0.07	0.68 ± 0.03	ABC 0.62 ± 0.06	0.28 ± 0.01	ABC 0.78 ± 0.01	0.35 ± 0.03
G_9	C 4.44 ± 0.01	2.70 ± 0.01	AB 1.43 ± 0.18	0.87 ± 0.11	BC 0.55 ± 0.11	0.33 ± 0.06	F 0.34 ± 0.01	0.21 ± 0.01
G_{10}	BC 5.13 ± 0.28	2.92 ± 0.68	AB 1.45 ± 0.10	0.83 ± 0.21	BC 0.54 ± 0.19	0.29 ± 0..06	EF 0. 44 ± 0.04	0.25 ± 0.03
G_{11}	C 4.72 ± 1.09	4.16 ± 1.58	AB 1.26 ± 0.07	1.08 ± 0.24	BC 0.43 ± 0.05	0.38 ± 0.11	CDE 0.58 ± 0. 11	0.5 ± 0.17
P>	0.0236		0.1392		0.0286		0.0025	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Influence of dietary fibers feeding on lipid pattern in rats .

The effect of consuming dietary fibers from different sources and levels for thirty days on hypercholesterolamic rats serum total lipids , total cholesterol and total triglycerides are shown in Tables (5, 6 and 7). From these results it could be seen that , feeding on diets supplemented with apple pomace reduced total lipids, total cholesterol and triglycerides contents in blood serum of hypercholesterolamic

rats and highly decreased values were recorded when rats were fed on diets supplemented with (10 , 5%) apple pomace. These results are confirmed with those of Gonzalez *et al*, (1998) and Amer (2002), who found that apple pomace fed rats had highly significantly lower total lipids, total cholesterol and triglycerides than the control group fed on basal diet only . On the other hand, supplementation of diet with 5% apricot peel (G_5) decreased total lipids, cholesterol and triglycerides contents (16.76, 34.06 and 57.98 %) than diet containing 10% (G_6) (15.42 , 28.78 and 50.16%) Tables (5,6 and 7) . From the results in the same tables it could be seen that, carrot peel supplemented diet at 10% highly significantly reduced total lipids, cholesterol and triglycerides levels compared to diet containing 5% carrot peel . These results are confirmed by Said , et. al (2000) who reported that there was a significant lowering of blood serum cholesterol levels and total lipids when carrot peel (200 gm) was added to the hypercholerolamic rats diet . Diet supplemented with 0.5% citrus pectin (G_9) was found to have the greatest lowering effect on total lipids, cholesterol and triglycerides contents in blood serum rats compared with other diets. A greatest reduction was observed in total lipids, total cholesterol and triglycerides in blood serum hypercholesterolamic rats (40.72, 44.87 and 58.92%, respectively) Tables (5,6 and 7). This decrement in lipid pattern shows the efficiency of pectin in lowering the total serum lipid and cholesterol level which could be acted as hypercholesterolamic potential in foods . These results are in accordance with those of Ali *et al.* (1991) ; Said *et al.* (2000) and Khalil, *et al.* (2002). They reported that, total serum cholesterol levels , total triglycerides and total lipids were significantly lowered in rats fed on pectin than in those fed on other dietary fibers . Moreover, feeding on high fat diet with drug (G_{11}) reduced total lipids (32%), serum total cholesterol (43.58%) and total triglycerides (42.25%) but the reduction was slight compared with feeding on diets supplemented with pectin . Generally, from these results it could be observed that, during repletion period (30 days) , feeding on diets containing dietary fibers had long term effect on lowering total lipids, total cholesterol and triglycerides. Citrus pectin (0.5 %) was found to have the greatest lowering effect followed by apple pomace (10%) then carrot (10%) and apricot peel (5%). This may be due to the action of pectin and other dietary fibers as absorbents, whereas the metabolites of fat components can be adsorbed on these materials .

Concerning the liver cholesterol of rats fed on different sources and levels of dietary fibers, results in Table (6) showed that, supplementing diets with 10% apple pomace (G_4) or carrot peel (G_8) reduced liver cholesterol contents (129.28 and 133.53 mg/100gm , respectively) compared to those groups fed on high fat diet containing 5% fibers. Supplementing diet with 0.5% citrus pectin highly decreased liver cholesterol content (129.73 mg /100 gm) and its lowering effect was approximately similar to diets fortified with drug (Omega 3A) (126.95 mg/100 gm) (G_{11}) . This means that , pectin has been consistently reported to be hypercholesterolamic dietary fibers and this is in accordance with the results reported by Said, *et al.* (2000) and Khalil *et al.* (2002). Pectin has long been known to be effective in lowering serum and liver cholesterol contents .

Table 5. Influence of dietary fibers on serum total lipids (g/dl).

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %
			15 days	30 days	
G1	A 515.0 ± 65.10	B 500.0 ± 87.70	B 461.0 ± 82.0	AB 492.5 ± 75.7	
G2	CD 368.5 ± 12.00	B 524.5 ± 14.84	A 576.5 ± 6.40	A 584.0 ± 4.24	
G3	BC 432. 5 ± 23.30	AB 569.5 ± 91.21	AB 480.5 ± 24.74	C 365.0 ± 86.30	37.66
G4	CD 398.0 ± 36.80	AB 567.5 ± 44.50	AB 482.0 ± 7.10	C 355.0 ± 17.0	35.68
G5	D 325.0 ± 69.30	B 516.0 ± 53.74	AB 472.5 ± 61.51	BC 429.5 ± 50.20	16.76
G6	CD 393.0 ± 24.04	B 522.0 ± 94.80	AB 482.0 ± 82.0	BC 441.5 ± 81.31	15.42
G7	CD 372.5 ± 2.12	B 506.0 ± 32.52	B 449.5 ± 36.10	BC 383.5 ± 44.54	24.21
G8	AB 494.5 ± 0.71	A 668.5 ± 16.30	AB 523.5 ± 2.12	ABC 466.5 ± 40.30	30.22
G9	AB 491.01 ± 7.10	A 665.5 ± 24.74	AB 515.5 ± 353	BC 394.5 ± 4.95	40.72
G10	C 409.0 ± 2.82	AB 633.5 ± 26.20	AB 494.0 ± 15.60	BC 390.0 ± 49.50	38.44
G11	CD 388.0 ± 9.90	AB 564.0 ± 48.10	AB 490.0 ± 11.31	BC 383.5 ± 16.30	32.00
P>	0.0021	0.0782	0.3092	0.0286	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Table 6 . Influence of dietary fibers on serum and liver cholesterol (mg/dl).

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %	Liver (mg/ 100gm)
			15 days	30 days		
	A	B	D	B		C
G1	94.08 ± 5.71	94.86 ± 2.42	92.75 ± 5.20	91.86 ± 4.70		129.05
	A	A	A	A		A
G2	99.90 ± 3.81	131.81 ± 12.14	155.27 ± 7.60	168.80 ± 1.00		194.45
	A	AB	BC	B		B
G3	103.90 ± 2.81	129.80 ± 7.94	115.80 ± 2.11	89.0 ± 5.23	31.43	140.85
	A	A	BCD	B		C
G4	95.52 ± 3.70	133.70 ± 0.90	108.30 ± 7.40	78.35 ± 4.94	41.40	129.28
	A	AB	BCD	B		B
G5	78.40 ± 18.20	119.70 ± 22.23	105.20 ± 20.40	78.93 ± 19.71	34.06	137.10
	A	AB	BCD	B		B
G6	102.40 ± 17.42	129.04 ± 1.23	107.60 ± 9.02	91.90 ± 1.50	28.78	140.15
	A	AB	CD	B		B
G7	98.30 ± 12.10	117.99 ± 3.30	101.22 ± 1.95	80.60 ± 1.20	31.69	139.65
	A	A	BCD	B		C
G8	88.74 ± 10.81	135.67 ± 9.10	104.50 ± 3.34	82.96 ± 4.10	38.85	133.53
	A	A	BCD	B		C
G9	98.41 ± 20.81	144.61 ± 11.10	104.02 ± 4.01	79.73 ± 6.50	44.87	129.73
	A	AB	D	B		C
G10	100.10 ± 29.10	125.0 ± 24.64	91.73 ± 4.70	75.76 ± 3.80	39.00	131.45
	A	A	B	B		C
G11	91.92 ± 27.13	141.10 ± 12.62	123.64 ± 14.37	79.61 ± 18.90	43.58	126.95
P>	0.9258	0.1392	0.0013	0.0001		0.0001

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Table 7. Influence of dietary fibers on serum triglycerides (mg/dl).

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %
			15 days	30 days	
G1	AB 100.00 ± 8.31	D 108.60 ± 9.54	F 106.80 ± 1.30	DE 104.92 ± 4.90	
G2	A 123.53 ± 8.31	ABC 247.70 ± 25.80	A 288.23 ± 8.32	A 316.20 ± 9.82	
G3	A 58.82 ± 16.63	CD 182.40 ± 25.00	EF 117.70 ± 0.00	E 97.31 ± 0.21	46.65
G4	BC 70.60 ± 16.63	BC 205.90 ± 25.00	CDEF 164.70 ± 16.63	E 98.10 ± 1.20	52.36
G5	A 123.53 ± 8.31	A 311.80 ± 41.64	BC 216.70 ± 5.53	BC 131.01 ± 14.90	57.98
G6	A 117.64 ± 16.63	AB 270.60 ± 16.61	DEF 141.20 ± 0.00	BC 134.88 ± 7.95	50.16
G7	A 129.41 ± 16.63	ABC 264.70 ± 8.34	BCD 194.12 ± 8.31	CD 123.89 ± 15.54	55.19
G8	ABC 92.94 ± 5.82	AB 276.50 ± 41.60	BCD 205.90 ± 58.23	E 83.72 ± 5.40	68.37
G9	A 129.41 ± 33.30	A 317.70 ± 83.22	AB 235.30 ± 66.54	B 130.53 ± 18.54	59.92
G10	A 111.80 ± 8.32	ABC 235.30 ± 33.23	BCDE 176.50 ± 16.63	E 102.63 ± 6.90	56.98
G11	A 117.64 ± 16.63	ABC 253.00 ± 8.30	BCD 200.00 ± 0.00	BC 146.10 ± 4.42	42.29
P>	0.0106	0.0041	0.0015	0.0001	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Results in Tables (8,9 and 10) show the changes in HDL.c, LDL.c and vLDL.c levels in rats serum fed on high fat diets supplemented with different levels and sources of dietary fibers. Referring to the data of lipid pattern it could be seen that increased levels of total cholesterol were associated with increases of LDL.c and vLDL.c levels while HDL.c was decreased . From the data in Table (8) it could be noticed that HDLc level was highly and significantly increased in rats fed on high fat supplemented with 10% carrot peel (G_8) followed by diet containing 5% apricot peel (G_5) then 10% apple pomace (G_4) compared with the other diets . The increasing HDL.c levels were 31.16, 29.74 and 29.92%, respectively. On the other hand , the aforementioned diets had highly and significantly decreased both LDL.c and vLDLc. The addition of 10% carrot peel to high fat diet (G_8) caused the highest vLDL lowering effect (68.36%) followed by feeding on diets supplemented with 5% apricot

peel (G_5) (58.01%) then 10% apple pomace (G_4) (52.38%) compared with rats fed on hypercholesterolamic diet containing drug (Omeg\ 3A) G_{11} which caused the lowest effect (43.66%) Table (10) . These results coincide with those reported by Bobek *et al.* (1998); Bobek (1999); Said *et al.* (2000) and Amer (2002), who found that increasing the levels of dietary fibers especially carrot peel and apple pomace in hypercholesterolemic diets had the highest reduced LDL.c and vLDL.c concentrations while HDL.c content was significantly increased . Meanwhile, feeding on hypercholeterolamic diet supplemented with 0.5% citrus pectin (G_9) had the highest effect on HDL.c raising (37.90%) than all other groups. LDL.c and vLD.c concentration of hypercholesterolamic rats serum fed on citrus pectin were highly reduced compared with diet containing tested drug (G_{11}) . The proportion of LDL.c and vLDLc were significantly lowered in rats fed on diets supplemented with both levels (0.5 and 1%) of citrus pectin . These results are in agreement with those reported by Ali, *et al.* (1991); Gonzalez, *et al.* (1998), Said *et al.* (2000); Hanczakowski, *et al.* (2001) and Khalil, *et al.* (2002). They found that supplementation of the diet with pectin reduced the concentration of LDL.c and vLDL.c while greatly increased the HDL.c levels compared with positive control diet. Generally , from these results , it could be observed that, feeding on diets containing dietary fibers and pectin had a fundamental role on lowering LDL.c and vLDLc whereas HDL.c highly increased .

Table 8. Influence of dietary fibers on serum HDL cholesterol (ml/dl) .

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Increasing %
			15 days	30 days	
G1	C 43.60 ± 1.40	ABC 42.10 ± 1.70	BC 42.02 ± 0.49	FG 41.83 ± 1.71	
G2	C 44.60 ± 3.74	C 32.30 ± 2.12	D 28.80 ± 1.20	H 22.08 ± 1.20	
G3	BC 47.70 ± 7.10	BC 37.70 ± 1.50	C 39.60 ± 0.18	EFG 45.00 ± 0.98	19.36
G4	A 63.00 ± 3.90	A 49.40 ± 2.12	A 55.50 ± 3.80	AB 62.70 ± 2.90	26.92
G5	C 44.00 ± 3.50	BC 37.80 ± 5.60	BC 42.60 ± 1.90	CDE 49.04 ± 0.33	29.74
G6	C 38.80 ± 1.83	C 32.30 ± 3.70	CD 34.90 ± 3.20	G 39.30 ± 1.30	21.67
G7	AB 59.00 ± 10.50	AB 44.20 ± 8.00	AB 51.30 ± 10.51	BC 56.54 ± 8.40	27.92
G8	A 64.90 ± 3.23	A 49.10 ± 2.90	AB 50.93 ± 1.90	A 64.40 ± 0.96	31.16
G9	C 44.80 ± 0.57	BC 35.20 ± 2.54	CD 39.02 ± 3.23	DE 48.54 ± 2.80	37.90
G10	BC 49.30 ± 2.90	BC 37.90 ± 3.74	CD 34.60 ± 4.00	DEF 47.71 ± 1.32	25.88
G11	C 39.50 ± 7.10	C 31.09 ± 6.90	C 39.30 ± 2.14	FG 41.50 ± 0.98	33.48
P>	0.0020	0.0046	0.0001	0.0001	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Table 9. Influence of dietary fibers on serum LDL cholesterol (ml/dl) .

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period	
			15 days	30 days
G1	30.48 ± 2.61	31.05 ± 1.19	29.33 ± 4.49	29.03 ± 2.02
G2	30.59 ± 1.63	49.98 ± 4.82	68.87 ± 4.70	83.48 ± 2.20
G3	44.40 ± 7.62	57.60 ± 1.44	52.67 ± 1.93	24.5 ± 4.21
G4	18.40 ± 3.53	43.10 ± 6.22	19.86 ± 0.28	3.97 ± 1.80
G5	14.89 ± 14.67	19.50 ± 10.20	26.96 ± 16.09	3.96 ± 15.41
G6	34.87 ± 10.59	39.13 ± 7.69	36.67 ± 7.12	12.56 ± 0.43
G7	13.41 ± 1.73	21.85 ± 6.40	11.09 ± 10.26	7.31 ± 10.31
G8	5.24 ± 6.38	30.27 ± 2.12	12.37 ± 10.21	6.24 ± 2.04
G9	27.71 ± 11.21	45.88 ± 9.29	17.90 ± 13.3	5.08 ± 1.47
G10	28.40 ± 26.83	44.70 ± 15.45	19.41 ± 1.86	3.69 ± 0.40
G11	28.89 ± 16.71	59.41 ± 4.02	44.34 ± 12.33	9.60 ± 17.82

Values are means ± SD, n = 6/group.

Table 10. Influence of dietary fibers on serum vLDL cholesterol (ml/dl)

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %
			15 days	30 days	
	AB	D	F	DE	
G1	20.00 ± 1.70	21.71 ± 1.91	21.40 ± 0.25	21.00 ± 0.97	
	A	ABC	A	A	
G2	24.71 ± 1.7	49.53 ± 5.20	57.60 ± 1.70	63.24 ± 2.00	
	C	CD	EF	E	
G3	11.80 ± 3.33	36. 50 ± 5.00	23.53 ± 0.00	19.50 ± 0.04	46.58
	BC	BC	CDEF	E	
G4	14.12 ± 3.33	41.20 ± 5.00	32.94 ± 3.32	19.62 ± 0.24	52.38
	A	A	BC	BC	
G5	24.71 ± 1.70	62.40 ± 8.33	43.34 ± 1.11	26.20 ± 3.00	58.01
	A	AB	DEF	BC	
G6	23.53 ± 3.33	54.11 ± 3.32	28.24+0.00	27.00 ± 1.60	50.10
	ABC	AB	BCD	CD	
G7	18.60 ± 1.20	55.30 ± 8.32	41.20 ± 11.65	24.80 ± 3.11	55.15
	A	ABC	BCD	E	
G8	25.9 ± 3.33	52.94 ± 1.70	38.83 ± 1.70	16.75 ± 1.10	68.36
	A	A	AB	B	
G9	25.9 ± 6.70	63.53 ± 16.65	47.10 ± 13.31	26.11 ± 3.71	58.90
	A	ABC	BCDE	E	
G10	22.40 ± 1.70	47.10 ± 6.65	35.30 ± 3.33	20.53 ± 1.40	56.41
	A	ABC	BCD	BC	
G11	23.53 ± 3.32	50.60 ± 1.70	40.00 ± 0.00	28.51 ± 0.10	43.66
P>	0.066	0.0041	0.0015	0.0001	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Effect of feeding on different levels of dietary fibers on the activities of serum transaminases GOT and GPT is shown in Tables (11 and 12) . From these data, it could be noticed that Feeding on diets containing fibers reduced the activities of liver enzymes in hypercholestrolamic rats . Diets supplemented with 10% apple pomace or apricot peel had significantly lowered liver enzymes activities than those supplemented with 5% . On the other hand , highly significantly decreases in both GOT and GPT (38.99 and 35.04%, respectively) were obtained when rats were fed on diets containing 5% carrot peel (G_7) than the other groups . Diet supplemented

with 0.5% citrus pectin decreased liver enzymes activity greatly (39% and 32.82% for GOT and GPT, respectively)and its lowering effect was approximately similar to diet fortified with drug (G_{11}) especially in lowering GOT than GPT, which was found to have the greatest lowering effect than the drug (G_{11}) . These results are in accordance with those reported by El-Zoghbi and Sitohy (2001); Hancakowski, *et al.* (2001) ; Khalil *et al* . (2002) and Amer (2002), who reported that , dietary fibers and pectin had a positive effect on lowering GOT and GPT . Finally, From these results it could be concluded that, dietary fibers could play a great role in lowering the activities of serum transaminases which affect greatly the liver function .

Table 11. Influence of dietary fibers on glutamic oxalacetic transaminase GOT (IU/I)

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %
			15 days	30 days	
G1	A 64.90 ± 6.20	A 68.10 ± 5.70	B 63.20 ± 4.44	B 65.31 ± 4.30	
G2	A 61.20 ± 3.20	A 71.90 ± 0.40	A 82.60 ± 1.54	A 100.80 ± 0.52	
G3	A 55.50 ± 7.21	A 66.80 ± 11.73	B 56.90 ± 7.42	CD 48.53 ± 6.40	27.35
G4	A 63.80 ± 5.51	A 69.90 ± 11.70	B 58.70 ± 2.20	CDE 44.81 ± 4.80	36.05
G5	A 66.10 ± 1.20	A 76.20 ± 3.60	B 62.52 ± 0.52	C 49.74 ± 1.72	34.72
G6	A 60.00 ± 1.62	A 66.50 ± 5.80	B 59.90 ± 14.40	F 33.32 ± 1.70	49.89
G7	A 61.50 ± 5.02	A 73.60 ± 2.33	B 59.53 ± 11.82	CDE 44.90 ± 1.50	38.99
G8	A 55.60 ± 5.02	A 67.40 ± 3.74	B 58.01 ± 1.90	CDE 46.30 ± 2.70	31.31
G9	A 57.70 ± 5.70	A 65.80 ± 7.40	B 59.50 ± 5.40	EF 40.14 ± 1.12	39.00
G10	A 63.60 ± 6.90	A 71.30 ± 2.50	B 61.90 ± 1.13	C 52.20 ± 1.22	26.79
G11	A 61.50 ± 5.02	A 73.50 ± 6.50	B 61.61 ± 3.54	DE 42.10 ± 2.80	42.72
P>	0.5177	0.8231	0.0247	0.0001	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

Table 12. Influence of dietary fibers on glutamic pyruvic transaminase GPT (IU/I) .

Treatments	After depletion period	After Hypercholesterolemic period	During repletion period		Reduction %
			15 days	30 days	
G1	A 22.60 ± 0.57	ABC 24.60 ± 1.60	A 24.0 ± 0.50	BC 23.11 ± 2.13	
G2	A 29.00 ± 7.10	ABC 34.80 ± 8.20	A 36.62 ± 7.10	A 39.11 ± 5.62	
G3	A 26.00 ± 4.00	BC 30.20 ± 2.12	CDE 26.50 ± 0.50	BC 24.30 ± 0.40	19.54
G4	A 26.20 ± 2.54	ABC 33.90 ± 9.50	BE 25.82 ± 5.00	BC 23.40 ± 0.72	30.97
G5	A 26.20 ± 0.70	AB 37.40 ± 0.42	ABCD 31.74 ± 2.00	B 28.91 ± 0.12	22.70
G6	A 27.10 ± 3.70	AB 38.40 ± 2.20	ABC 33.01 ± 1.60	B 28.70 ± 3.52	25.26
G7	A 24.50 ± 0.42	A 41.30 ± 0.42	AB 34.52 ± 1.14	B 26.83 ± 4.24	35.04
G8	A 25.00 ± 3.81	ABC 32.30 ± 2.40	BCDE 29..41 ± 1.53	BC 24.00 ± 0.72	25.70
G9	A 22.70 ± 1.90	ABC 32.30 ± 0.50	DE 25.40 ± 0.61	C 21.70 ± 0.70	32.72
G10	A 28.90 ± 6.60	ABC 33.90 ± 4.52	CDE 26.80 ± 1.60	BC 23.91 ± 2.52	29.47
G11	A 25.00 ± 5.10	AB 36.20 ± 2.50	ABCD 32.01 ± 2.00	B 28.40 ± 6.00	21.55
P>	0.6622	0.1119	0.0129	0.0009	

Values are means ± SD, n = 6/group.

ABCDE : Means in the same column with different superscripts differ significantly (p> 0.05) .

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الاستفادة من مخلفات مصانع حفظ الأغذية كمصدر للألياف الغذائية وتأثيرها على بروتينات الدم فى فئران التجارب

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فـــى هذه الدراسة تم استخدام مخلفات مصانع حفظ الأغذية وخاصة تفل التفاح والمشمش والجزر والتى تعتبر من المصادر الغنية بالألياف الغذائية بالإضافة إلى بكتين الموالح وذلك بغرض دراسة تأثير إضافة تلك المصادر فى الوجبات الغذائية على كل من مستوى الكوليسترول فى سيرم الـــدم ومشـــتقاته مـــثال البروتيـــنات المرتفعة الكثافة (HDL) والمنخفضة الكثافة (LDL) وشديدة انخفـــاض الكـــثافة (vLDL) أيضـــاً التغيرات فى الأنزيمات الوظيفية للكبد مثل إنزيم الجلوتاميك أوكســـالو أسيتات ترانس أمينيز (GOT) والجلوتاميك بيروفات ترانس أمينيز (GPT) تم قياسها فى سيرم الدم وقد تم إمراض الفئران من خلال التغذية على وجبات عالية الدهون والكوليسترول و تم التوصل إلى النتائج التالية :

التغذية على الوجبات الغنية فى الدهون والمحتوى على ١٠% ألياف غذائية أو ١% بكتين أدت إلـــى زيـــادة معدل الاستفادة من الغذاء وزيادة وزن الجسم أى أنه بزيادة محتوى الألياف فى الوجبة الغذائية ذادت المقاييس التغذوية بالإضافة إلى زيادة معدلات النمو فى الفئران . الفئران التى تـــم تغذيتها على وجبات بها ٥% أو ١٠% من كل من تفل المشمش أو الجزر أدت إلى زيادة وزن الأعضـــاء وخاصة الكبد والكلية عن التى تم تغذيتها على باقى الوجبات تحت الدراسة . كذلك وجد أن التغذية على وجبات تحتوى على الألياف الغذائية أدت إلى خفض كبير فى كل من الدهون الكلية والكوليســـترول والجلســـريدات الثلاثـــية بينما الوجبات المحتوية على ٠,٥ % بكتين حققت أعلى معـــدلات خفض يليها الوجبات المحتوية على ١٠% تفل تفاح ثم ١٠% تفل جزر وأخيراً ٥% تفل مشمش. أيضاً زيادة محتوى الألياف فى الوجبة أدت إلى خفض تركيز الكوليسترول فى الكبد وعلى النقيض من ذلك احتواء الوجبة على تركيز منخفض من البكتين ٠,٥% أحدث أعلى معدلات خفض فـــى مســـتوى الكولســـيترول فى الكبد . ارتفعت مستوى البروتينات المرتفعة الكثافة فى الوجبات المحتوية على ١٠% ألياف عن المحتـــوية على ٥% وقابل ذلك انخفـــاض فى كل من (vLDL) و(LDL). أيضاً إضافة ٠,٥% بكتين إلى الوجبـــة أحدث ارتفـــاع فى مستـــوى(HDL) حوالى (٣٧,٩%) وســـبب انخفاض معنوى فى البروتينات المنخفضة وشديدة الانخفاض فى الكثافة وذلك عـــن التغذية على الوجبة المحتوية على العقار الطبى المستخدم (Omega 3A) . أخيراً استخدام الألياف الغذائية والبكتين أظهر تأثير ملحوظ فى خفض أنزيمات (GOT) و (GPT) .