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EFFECT OF SOME FRUITS AS FEED ADDITIVES AND THEIR ROLE AGAINST HYPERLIPIDEMIA AND OBESITY OF EXPERIMENTAL RATS.

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ABSTRACT

Hyperlipidemia and obesity are associated with many diseases which badly affective on health. Increased consumption of fruits is widely recommended to improve health and decrease overweight and the lipid level in the blood. Forty albino male rats weighing 119±2 g used in this study. All rats fed on basal diet for two weeks for adaptation , after this period , rats divided into two main groups .The first group (8rats) fed on basal diet throughout the experimental periods (4 months) and considered as a negative control group , while the second group fed on high fat diet for two months, then this group divided to four subgroups (n = 8 rats of each).The first four subgroups were continued fed on high fat diet with apple , kiwi and combination of them. subgroup (1) positives control (1) fed on high fat diet ,subgroups (2,3and4) fed on high fat diet containing (apple , kiwi and combination of them) respectively. The results revealed a significant increase in the body weight from positive control of high fat diet rat groups. Also a significant increase of level of lipid profile, liver enzymes and kidney function compared to negative control grope were found. While feeding rats with high fat diet containing apple, kiwi and combination of them showed significant decrease in body weigh, liver enzymes , kidney function and level of lipid profile (TC, TG, TL and LDL) and increase in the level of HDL .In Histopathological study change in cells liver, kidney, heart and brain in rats, were observed.

Keyword: Hyrerlipidemia, obesity, apple and kiwi

INTRODUCTION

Fats play an important part of our daily diet. During the past twenty years, there has been an explosion of research on the significance of fats in health and disease. There is considerable evidence which links fats with many of the most common forms of degenerative diseases (Soltan, 2014). Hyperlipidemia is an elevation of lipids in the bloodstream. It is the condition of abnormally elevated levels of lipids and lipoproteins in the blood (Gouda, 2014). It is a common disorded in developed countries and the major cause of coronary heart disease that result from high levels of fats in blood (Vuyyuru *et al.,* 2012) . Hyperlipidemia is one of the main causes of deaths from cardiovascular disease. Hypercholesterolemia is observed in most industrial societies where poor nutrition with food containing saturated fats and cholesterol (Nouri, and Rezapour, 2011), which is a risk factor for cardiovascular disease (CVD) (Nasiru and mohammad, 2012). The global prevalence of obesity has increased considerably in the last decade (Hursel and Westerterp, 2010). Obesity is becoming a significant problem for many countries around the world. Rate of obesity have reached epidemic levels, and both find and developing countries are now affected (Nabhan, 2012). El-Sayed *et al.,* (2011) indicated that obesity is an important determinant of cardiovascular disease risk, and is associated with risk for hypertension, hypercholesterolemia, angina pectoris and coronary heart disease. Obesity is also associated with several other disease including diabetes mellitus, cancer, rheumatoid and osteorthritis and depression among several others . Among children, obesity predicts orthopedic abnormities, idiopathic intracranial hypertension, Asthma, sleep apnea, gallstones, insulin resistance and subsequent diabetes mellitus and poor mental health. High dietary fibers are being advised as a treatment and management of various metabolic disorders. Their effect on cholesterol and lipoprotein metabolism varies based on their composition (Ramzy, 2013).

A large body of evidence indicates that the risk of degenerative disease such as obesity, atherosclerosis, diabetes and cancer is considerably lower in people who consume above average amount of fruits and vegetables (Franch *et al.,* 2013). Several large – scale studies have also shown that a regular intake of fruits and vegetables is associated with low total cholesterol, low – density lipoprotein (LDL) – cholesterol, triglycerides and total / high – density lipoprotein (HDL) (Parrilla *et al.,* 2010) , and that rich diets in fruit positively influence plasma lipid level (leontowicz *et al.,* 2003).

Positive effects of fruits and vegetables have been attributed to dietary fiber, antioxidants, and especially phenolic compounds. Fibers and polyphenols are capable of improving the lipid profile in cardiovascular patients. Apple is one

of those fruits which can play a role in decreasing the risk of chronic disease (Vafa *et al.,* 2011). Apple has shown significantly health benefits as a famous quote from American " An apple a day keeps the doctor a way' (Liu *et al.,* 2010).

Apple in human diet are an important source of different biological active natural plant products, which can contribute positively to prevention of several diseases (Kviklys *et al.,* 2014).Apple fruits are dependable source of vitamins, it is rich in fiber, electrolytes, minerals and antioxidants and it is usually eaten fresh and raw, making the vitamins fully available for the body (Oranusi and Wesley, 2012)

Some kiwi fruit consistuents may make important contributions to human nutrient requirements. Kiwifruits are good sources of folate and potassium and contain large amount of vitamin E in the seed. This fruit also contains about 2% to 3% dietary fiber. Sensory acceptance of kiwi fruit is also dependent on the presence of calcium oxalate in all varieties. Kiwi fruit also contains different pigments including chlorophyils, carotenoids, lutein, and anthocyanins (Singletary, 2012) .

Kiwi is particularly rich in vitamin C (ascorbic acid), and also contains a wide range of other phytochemicals. The common green kiwi, Actinidia deliciosa, has been used as a "model" fruit in several trials to examine effects on biomarkers relevant to both cancer and CVD. (Brevik *et al.,* 2011). Kiwi is rich in polyphenols and has immune activity. Polyphenols are widely known for having anti – oxidant effects (Khalid, 2012) The aim of the present work is to study the effect of diet containing (apple, kiwi and combination of them) on the nutritional evaluation and biochemical parameters of rats, suffering from high level of lipid and obesity.

MATERIALS AND METHODS

Animals :

Forty two albino male rats weighing 119±2 g used in this study. were obtained from the Biological Laboratory of chemistry Department, Faculty of Agriculture, Minia University. Rats were housed in special healthy plastic cages and maintained on *ad libitum* for water and free access of basal diet. Rats divided into five groups as following:-

Group (1): Negative control (C -); rats fed on basal diet only.

Group (2): Positive control (C +); rats fed on high fat diet composed of basal diet +10% animal fat.

Group (3): Rats fed on high fat diet + 20% dried apple (AP).

Group (4): Rats fed on high fat diet + 20% dried Kiwi (KI).

Group (5): Rats fed on high fat diet + 20% combination of dried (apple + kiwi) (AK).

Fruits, fats and chemicals:

- Apple and Kiwi were obtained from a local market, Minia, Egypt during March and April. Fruits were prepared for drying process by manual sorting and washing with water and cut in to slim slides and dried. The drying process has been carried out at 40 – 45 C° by oven under vacuum (Yousif, 2010) Then the dried fruits ground to fine powder and used for rat feeding.

-Animal fats were purchased from the local market then milted and blended it directly with experimental diet.

-chemicals: used to determine serum total lipids (TL), total cholesterol (T C), triglycerides (TG), LDL – C, HDL – C, GPT, GOT, Urea, Protein, Albumin, Lipid Peroxide, Nitric oxide and Alkaline phosphatase. Were purchased from Biomed a new Era of Biodiagnostics (Egypt). All other chemicals were of the highest available commercial grade.

Basal diet:-

The basal diet consisted of: Casein 20%, corn oil 5%, Salt Mix 4%,

Vitamin Mix 1%, Cellulose 5% and Starch 65% according to Compbell, (1961).

+10% animal fat.

Blood Samples:-

The body weight was recorded throught the period of experiment. At the end of experimental period (16 week), rats were fasted for 12 hours. Blood samples were taken from the retro-orbital plexus from all animals of each group after anesthetized by diethyl 1 ether. Each sample was centrifuged at 3000 rpm for 15 min, The obtained supernatant (serum) kept at – 20 C° until used in biochemical analysis. Animals were dissected as quickly as possible and liver, Kidney, Spleen, heart, brain and testis were excised, washed in ice-cold saline, wiped with filter paper and weighted.

Biochemical analysis:-

Serum level of total cholesterol, HDL- cholesterol and triglycerides were determined according to the methods of Tietz (1976), Castelli (1977) and Vassault (1986) respectively, LDL- cholesterol (LDL-C) level was calculated according to Watson (1960) ,total lipid level was calculated according to(Zollner and Kirsch , 1962) , lipid peroxide ,alkaline phosphatase , nitric oxide were determined according to the methods of Ohkawa et al ., (1979) , (Belfield and Goldberg , 1971) , (Montgomery and Dymock, 1961) respectively, GOT and GPT were measured with colorimetric method (Henry 1964). Total protein, albumin and urea were determined according to Gornal et al (1949) and (Fawcett and soctt , 1960) respectively.

Histopathological techniques:

Small pieces of each of liver, kidney, brain, heart and testis of each animal of control and treated group were fixed in 10% formal saline solution for twenty four hours. Washing was done using tap water then serial dilutions of absolute ethyl alcohol were used for dehydration.

After routine processing, paraffin bees wax tissue blocks were prepared for sectioning at 4 microns thickness by slidge microtome. The obtained tissue sections were collected on glass slides, deparaffinized and stained by hematoxylin and eosin for histopathological examination through the light microscope Banchroft *et al.,* (1996).

Statistical analysis :

Statistical analysis was performed with SPSS computer program (SPSS, 1990) software. The results obtained in the present study were evaluated by one way ANOVA (analysis of variance) test. The results were expressed as mean $\pm$ standard deviation. Significant differences among sub .class means were,detected using the method of least significant difference.

RESULTS AND DISCUSSION

Body weight:-

Results in table (1) show that the body weight of positive control (C +) group was higher than that of Negative control (C -) group. Negative control has significantly ($P < 0.05$) higher body wight increase rate of 24.06% than C + (15.72%). However, body weight value of groups which fed on apple (AP), Kiwi (Ki) and combination of them (AK) were significantly ($P < 0.05$) lower than positive control group. These results are in agreement with that of Boque *et al., (* 2013) who reported that the administration of apple polyphenol protects against body weight gain and fat deposition in rats. Cho et al (2013) indicated that supplementing apple products such as apple pomace and apple juice concentrate may help suppress body weight and white adipose tissue gain. Shehata and Soltan (2013) found that the reduced in body weight gain of kiwi and avocado fruit may be due to higher content of crude fiber,

2 – Organ weighted :

Changes in Liver, Kidney, Spleen, Heart, brain and tests weight relative to the total body weight are shown in Table 2 and 3. No significant differences were found in brain weight or testis weight between the groups. The weight of the Liver, Kidney, Spleen and Heart in the C + group were increased significantly $P < 0.05$than that at the C - group, while in the treated group with (apple, kiwi and combination of them) the weight of the liver, Kidneys, Spleen and heart were decreased significantly ($P < 0.05$)

Effect of dried apple, kiwi Fruit and combination of them on total lipid (T, L) lipid peroxide.

The changes in total lipid and lipid peroxide are shown in Table (4) .The C + group significant difference($p<0.05$)in total lipid compared to C - group with decresing percent of - 21.10%. However, the values of total lipid and lipid peroxide were decreased significantly ($P <0.05$) in rats fed on high fat diet treated with apple, kiwi and combination of them). The percentage of decrease were (- 16.81, - 24.46 and 21.68) %

respectively in total lipid and (- 13.54, 14.46 and – 22.19) % // in lipid peroxide. These results are in accordance with those reported by Aprikian *et al.,* (2002) who found that apples improve substantially the lipid status and peroxidative parameters in obese zuker rats. Keith, (2012) indicated theupon feading with diets supplemented with Kiwe lowering of blood lipid levels. Table serum TG, TC, HDL and LDL level:-

Table (5, 6) shown significant (P < 0.05) increase in the level of serum TC, TG and LDL-C for the C +) group compared to C - group. A significant decrease in serum HDL-C for C + group compared to C - group. The groups treated with apple, kiwi and combination of them were significantly lower (P < 0.05) level of TC than C + group with decreasing percentage (- 25.56, - 22.60 and – 23.32) % respectively,

Similarly, the elevation of TG level showing significant difference, with percent of decrease (- 7.32 %) for C - group compared to C+ group. The TG value of groups treated with apple, kiwi and combination of them were significantly lower (P < 0.05) than that of the positive control. Also LDL-C was significantly (P < 0.05) lower in groups treated with fruit (apple, kiwi and combination of them by (- 33.24, - 30.43 and – 33.37) % respectively as compared with C + group. Meanwhile, HDL-C was significantly (P < 0.05) increase in groups treated with (apple, kiwi and combination of them) by (+ 14.29, + 24.26 and + 40.15) % respectively when compared with positive control group. The results appear to be in agreement with those of Nouri and Rezapour, (2011) who found that the apple reduced the amount of TC, LDL and TG and increased HDL levels in rat.

Liver enzymes activity

Table (7) the levels of Got and GPT were higher than that of negative control (C -) group. The values of Got in groups treated with apple, kiwi and combination of them, were significantly (P < 0.05) decreased by - 26.09, 40.85and– 41.70% respectively, when compared to C + group.

These results were in agreement with Abdel-Rahim and El Beltagi, (2010) found that apple improvement the activity of two transaminases (GOT and GPT). Shehata and Soltan, (2013) indicated that supplemented diet with different concentration fruits and seeds of Kiwi reduced the AST and ALT activities

Effect of fruits on nitric oxide and alkaline posphatase.

Table (8) shown that a significant (P < 0.05) increase in the level of No and ALP in the C + group compared to C - group. While the level of No and ALP groups treated with fruits (apple, kiwi and combination of them) were significantly lower (P < 0.05) than positive control.

Serum protein, albumin, Globulin and urea

Urea in all group treated with apple, kiwi and combination of them

were decreased compared to C + group.(table 8). Protein, albumin and Globulin in the groups treated with fruit (apple, kiwi and combination of them) were lower than of the positive control group.

Histopathological results :

Figure (1) shows that liver of rats from negative control group (A) revealed normal histological structure of hepatic lobule on the other hand, liver of rats of the positive control group (B) showed fatty change of hepatocytes while liver of rats which treated with kiwi (D) and combination of apple and Kiwi a (E) showed no histopathological changes.

Microscopilly, kidney of rat from negative control shows normal histological structure of renal parenchyma (Fig 2 A), meanwhile, the kidney of rat from positive control group (B) showed congestion of intertubular blood vessels and vacuolation of endothelial lining glomerular tuft. However, kidne of rats which treated with apple (C) showed hypertrophy and congestion of glamerular tuft. While kidney of rats which treated with kiwi (D) showed no histopathogical changes but rats which treated with combination of apple and kiwi (E) showed slight congestion of glomerular.

Fig (3)shows that heart of rat from negative control group (A) normal cardiac myocytes where as the positive control group (B) showed intermyocardial oedema. While Heart of rats which treated with apple, kiwi (D) and combination of them (E) showed no histopathological changes.

Fig (4) shows that brain of rat from negative control (A) showed no histopathological changes. However brain of positive control group (B) showed congestion of blood vessel. Brain from rats which treated with apple (C) showed cellular oedema but the brain of rats which treated with kiwi (D) and combination of apple and Kiwi (E) showed no histopathological changes.

CONCLUSION :

It could be concluded that apple, kiwi and combination of them can achieve reduce in lipid profiles, kidney function, liver enzymes activities, lipid peroxidation Nitric oxide and alkalin phosphates. In addition increases in HDL and resulting in normalization. Apple and kiwi can reduced the body weight.

Table (1): Effect of dried (apple, kiwi and combination of them) on mean body weighted rats:-

Groups	Initial weight (g)	Weight (g) After two months	Final Weight (g)	Body weight %
C-, Negative control	119.4± 6.4	256.9± 23.5	297.3 \± 26.8	15.72
C+1m Positive control	118.6± 5.4	311± 16.6[a]	385.83± 39 [a]	24.06
AP1	117.2± 4.2	298.9± 20[a]	311.1±20.2[b]	4.08
KI1	120.1 ± 5.9	292.1± 34.9[a]	312±37.6[b]	6.37
AK1	119.7 ± 6.2	312.6±46.7[a]	320.2±44.1[b]	*2.43*

Table(2): Changes in relative organ weights of rat organs:-

Groups	Liver wt (g)	%	% Change of control (+)	Kidney Wt (g)	%	% Change of control (+)	Spleen wt (g)	%	% Change of control (+)
C- Negative control	8.5 ± 1.6	2.85	- 19.81	1.7 ± 0.2	0.44	-22.72	0.9 ± 0 .2	0.32	-18.18
C+1 Positive control	10.6 ± 1[a]	2.74	**.....**	2.2 ± 0 .1[a]	0.57	**.....**	1.1 ± 0.1a	0.28	**.....**
AP1	7.7 ± 0 .7[b]	2.47	-27.35	1.8 ± 0 .1[b]	0.57	18.18-	0.9±0 .06[b]	0.28	-18.18
KI1	7.5 ± 0.8[b]	2.40	-29.24	1.8 ± 0 .2[b]	0.57	18.18-	0.8 ± 0.1[b]	0.25	-27.27
AK1	8.3 ± 0 .7[b]	2.59	-21.69	1.7 ± 0 .2[b]	0.56	-22.72	1 ± 0.04[b]	0.31	*-9.09*

Table(3): Changes in serum TG, TC, HDL and LDL level of rats.

Groups	Heart wt (g) M ± SD	%	% Change of control (+)	Brain wt (g) M ± SD	%	% Change of control (+)	Testis wt (g M ± SD	%	-
C- Negative control	0.9 ± 0.11	0.30	-18.18	1.5 ± 0.20	0.50	-11.76	2.9 ± 0.4	0.97	-9.37
C+1 Positive control	1.1 ± 0.12 [a]	0.28	**.....**	1.7 ± 0. 20	0.44	**.....**	3.2 ± 0.14	0.82	**.....**
AP1	0.8 ± 0.06 [b]	0.25	-27.27	1.6 ± 0.22	0.51	-5.88	2.9 ± 0.14	0.93	-9.37
KI1	0.8 ± 0.09 [ab]	0.25	-27.27	1.6 ± 0.11	0.57	- 5.88	3.1 ± 0.42	0.99	-3.12
AK1	0.9 ± 0.08 [b]	0.28	-18.18	1.5 ± 0.96	0.49	-11.76	2.7 ± 0.34	0.90	*-15.62*

± = SD standard deviation; significantly different from Negative control ([a]) & Positive control ([b]) group at P < 0.05.

Table (4): Effect of fruits (apple, kiwi Fruit and combination of them) on total lipid and lipid peroxide.

Groups	Total-lipids (TL) (mg/dl)	% Change of control(+)	Lipid Peroxide (nmol/ml)	% Change of control (+)
C- Negative control	494.18 ± 36.66	- 21.10	10.02 ± 0.34	- 16.70
C+1 Positive control	626.35 ± 25.55 [a]	.....	12.03 ± 0.38 [a]	.....
AP1	521.01 ± 44.82 [b]	- 16.81	10.40 ± 0.37 [b]	- 13.54
KI1	473.12 ± 17.39 [b]	- 24.46	10.29 ± 0.40 [b]	14.46-
AK1	490.50 ± 42.60 [b]	- 21.68	9.36 ± 0.68 [ab]	*- 22.19*

Table(5): Changes in serum TG, TC, HDL and LDL level of rats.

Groups	Total - cholesterol (TC) (mg/dl)	% Change of control(+)	Triglycerides (TG) (mg/dl)	% Change of control(+)
C- Negative control	142.62 ± 5.82	-25.03	143.51 ± 12.82	- 7.32
C+1 Positive control	190.25 ± 8.51 [a]	.....	154.85± 11.01[a]	.....
AP1	141.62 ± 3.02 [b]	- 25.56	139.08± 14.61 [b]	- 10.18
KI1	147.25 ± 1.75 [b]	- 22.60	139.15 ± 14.54[b]	- 10.13
AK1	145.87 ± 5.19 [b]	- 23.32	140.89 ± 4.92 [b]	*-9.01*

Table (6): Changes in serum TG, TC, HDL and LDL level of rats.

Groups	HDL(mg/dl) M ± SD	% Change of control(+)	LDL(mg/dl) M ± SD	% Change of control(+)
C- Negative ontrol	25.42 ± 2.75	61.49+	88.74± 5.64	- 38.17
C+1 Positive ontrol	15.74 ± 0.46 [a]	.....	143.53 ± 7.35 [a]	.....
AP1	17.99 ± 0.64 [ab]	14.29+	95.81 ± 2.02 [ab]	- 33.24
KI1	19.56 ± 0.81 [ab]	+ 24.26	99 .85± 3.12 [ab]	- 30.43
AK1	22.06 ± 1.21 [ab]	+ 40.15	95.63 ± 4.35 [ab]	*- 33.37*

± = SD standard deviation; significantly different from Negative control ([a]) & Positive control ([b]) group at P < 0.05.

Table (7) Changes in Liver enzymes activity :

Groups	GOT (u/l)	% Change of control(+)	GPT (u/l)	% Change of control(+)
C- Negative control	20.36 ± 2.58	- 41.87	6.56 ± 0.72	- 40.57
C+1 Positive control	35.03 ± 1.49 [a]	.....	11.04 ± 0.30 [a]	.....
AP1	25.89 ± 0.33 [ab]	-26.09	8.75 ± 0.79 [ab]	- 20.74
KI1	20.72 ± 1.79 [b]	- 40.85	7.34 ± 0.67 [ab]	- 33.51
AK1	20.42 ± 1.92 [b]	- 41.70	6.30 ± 0.37 [b]	*- 42.93*

Table (8):- Effect of apple, kiwi fruits and their combination on nitric oxide and alkaline posphatase in rats .

Groups	Nitric Oxide mmoi/l	% Change of control (+)	Alkaline Phosphatase (iu/l)	% Change of cont l (+)
C- Negative control	22.29 ± 0.95	- 13.58	103.56 ± 4.55	-12.43
C+1 Positive control	25.87 ± 1.22 [a]	.....	118.27 ± 7.45 [a]	.....
AP1	24.10 ± 0.56 [ab]	- 6.84	112.12 ± 6.26 [ab]	- 5.19
KI1	23.53 ± 0.35 [ab]	- 9.04	111.55 ± 6.23 [ab]	- 5.68
AK1	22.80 ± 0.38 [b]	- 11.86	103.48± 1.08 [b]	*- 12.68*

Table(9):- Changes in serum protein, albumin, Globulin and urea

Groups	Urea (mg/dl)	% Change of control (+)	Protein (mg/dl)	Albumin(mg/dl)	Globulin(mg/dl)
C- Negative control	43.91 ± 2.40	- 3.38	6.63 ± 0.24	4.17± 0.20	2.46 ± 0.28
C+1 Positive control	45.45 ± 0.83	.....	7.19 ± 0.42 [a]	4.29 ± 0.36	2.89 ± 0.47
AP1	37.55 ± 4.94 [ab]	- 17.38	6.53 ± 0.69 [b]	4.08 ± 0.32	2.44 ± 0.76
KI1	41.47± 2.06 [b]	- 8.75	6.93 ± 0.64	4.13±0.34	2.79 ± 0.72
AK1	43.06 ± 1.43	- 5.25	6.75 ± 0.49	3.88 ± 0.20 [b]	*2.87 ± 0.48*

± = SD standard deviation; significantly different from Negative control ([a]) & Positive control ([b]) group at $P < 0.05$.

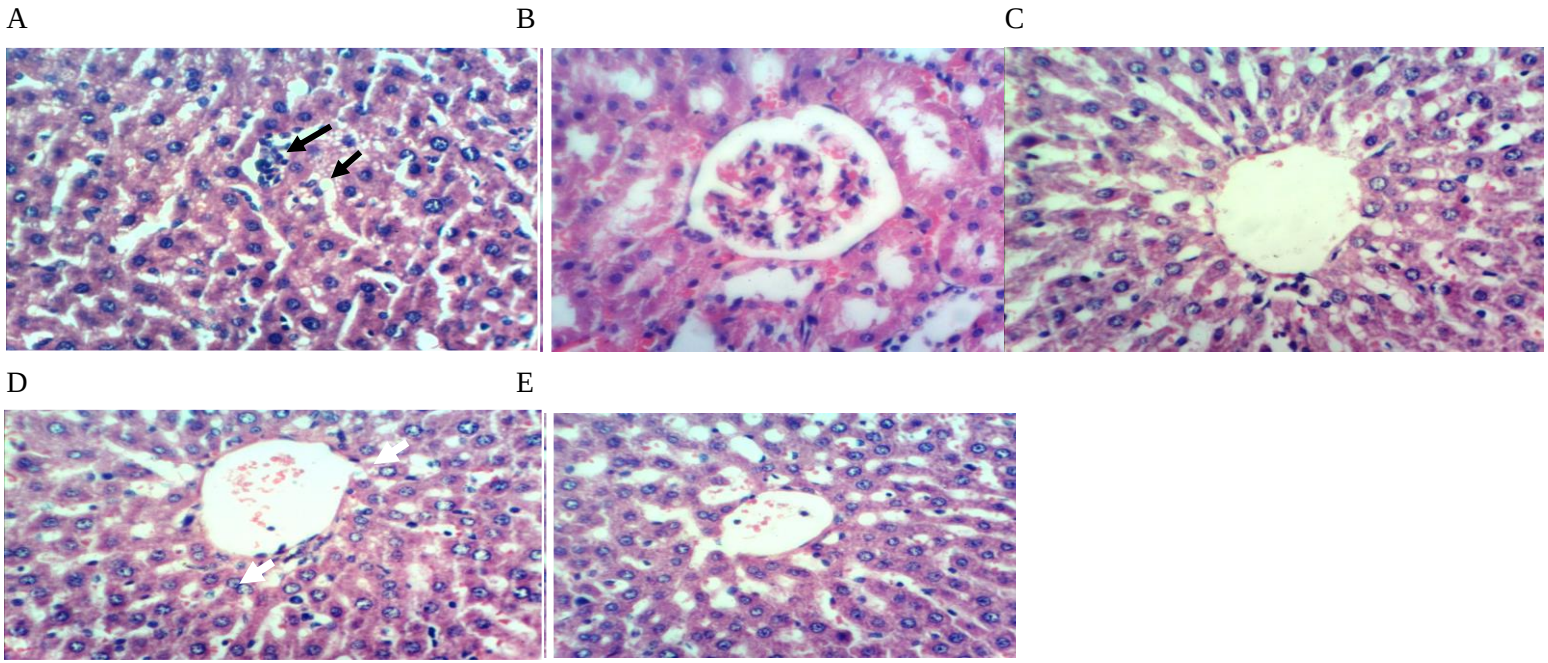

Fig 1 : Liver Histological structure of rats in negative control group (A), positive control group (B), treated with 20% apple (C), treated with 20% kiwi (D) and rats treated with 20% of apple and Kiwi each combination of them (E).

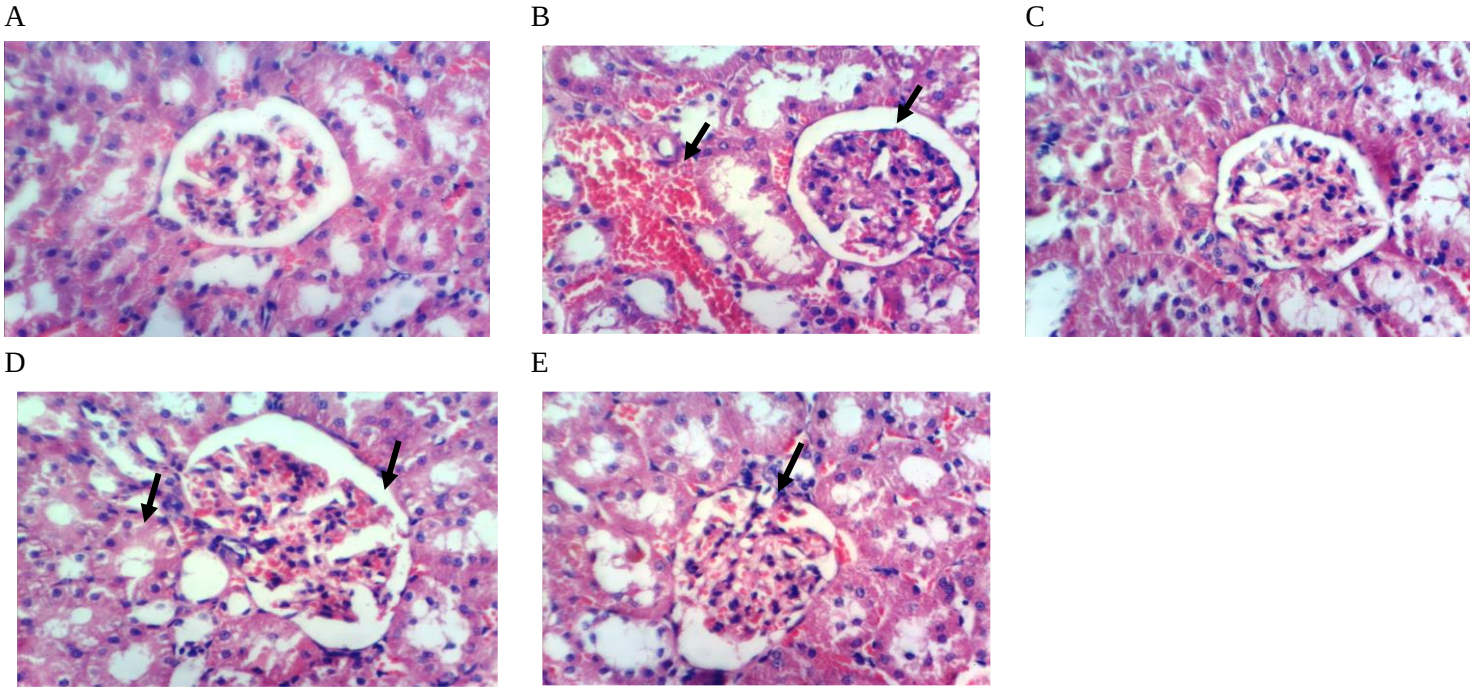

Fig 2 : Histological examinations of kidney tissues of rats in negative control group (A), positive control group (B), treated with 20% apple (C), treated with 20% kiwi (D) and rats treated with 20% of combination of them (E).

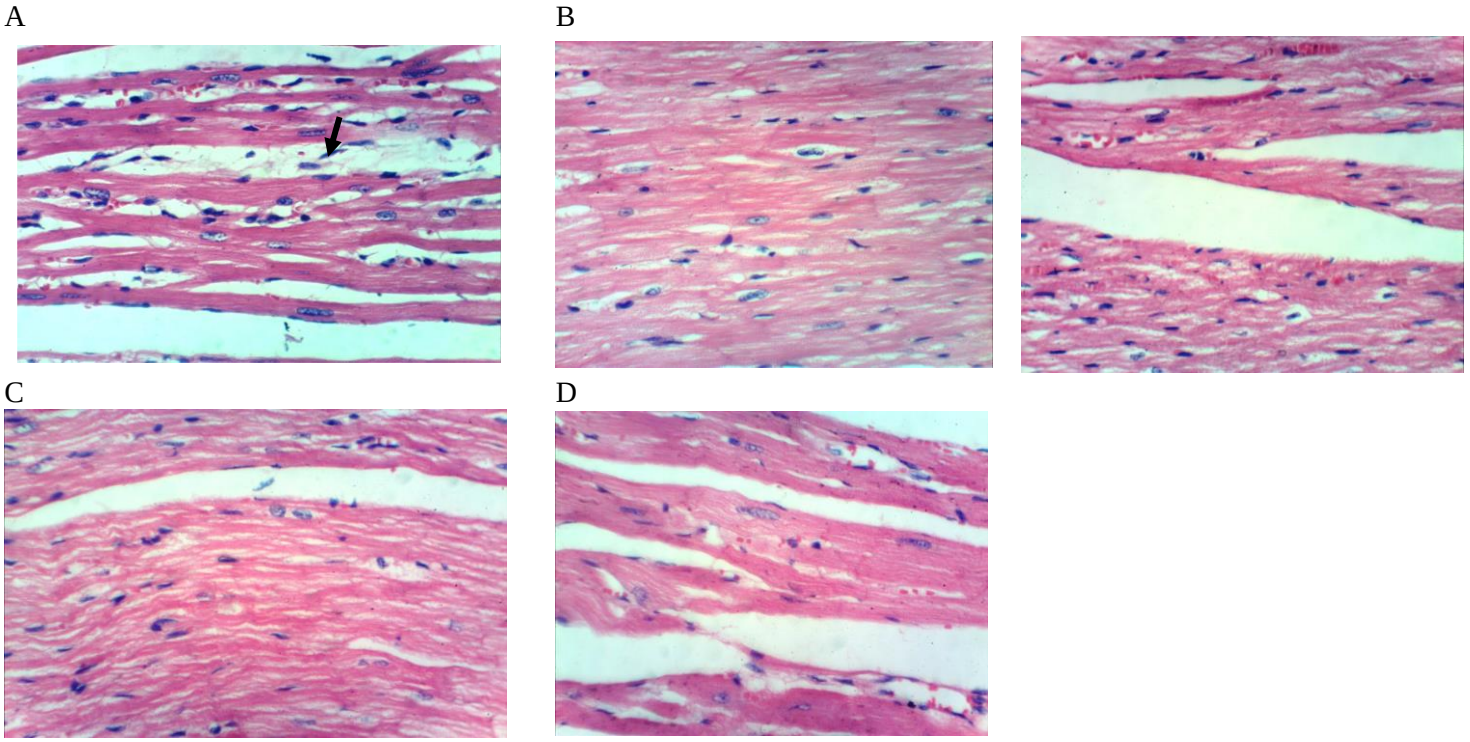

Fig 3 : A photomictograph of the heart of rats in negative control group (A), positive control group (B), treated with 20% apple (C), treated with 20% kiwi (D) and rats treated with 20% of each apple and Kiwi (E).

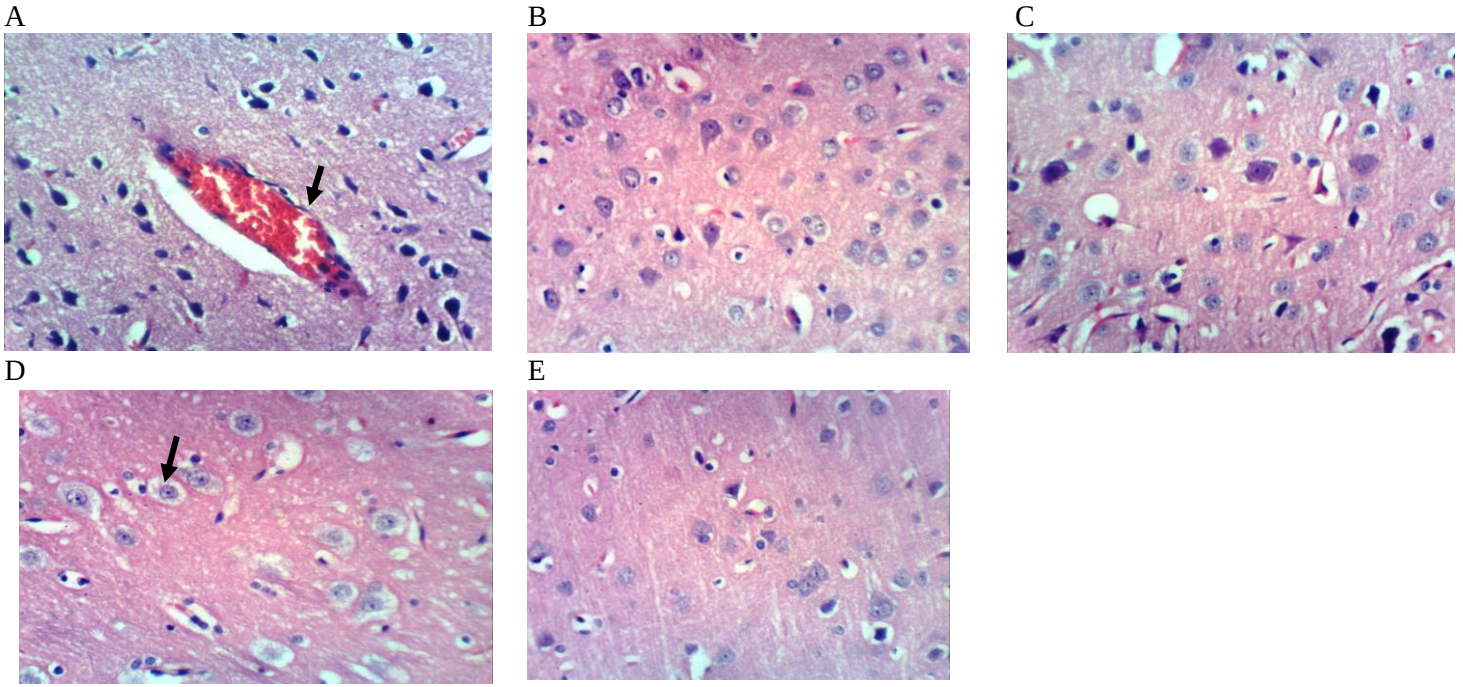

Fig 4 : A photomictograph of the heart of rats in negative control group (A), positive control group (B), rats which treated with 20% apple (C), rats which treated with 20% kiwi (D) and rats treated with 20% combination of them (E).

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الملخص العربي

تأثير بعض الفاكهة كإضافات غذائية ودورها فى مقاومة ارتفاع مستوى الدهون والبدانة فى فئران التجارب

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ترتبط البدانة والدهون بالعديد من الأمراض التي تؤثر على المستوى العام للصحة ولقد أصبح زيادة استهلاك الفاكهة مطلوبة بشكل كبير لتحسين الصحة وتقليل زيادة الوزن وارتفاع مستوى الدهون في الدم . ولقد استهدفت الدراسة التحقق من فعالية تأثير الوجبات الغذائية التي تحتوى علي التفاح والكيوي والخليط من التفاح والكيوي على مستوى التغذية والتحليلات الكيميائية للفئران التي تعانى من ارتفاع مستوى الدهون وزيادة وزن الجسم .

استخدم 40 من ذكور فئران الألبينو 119±2 جرام والتي غذيت لمدة أسبوعين على الوجبة الأساسية المتوازنة وذلك للتكيف ، وبعد هذه الفترة قسمت الفئران إلى مجموعتين رئيسيتين الأولى مكونة من 8 فئران غذيت على الوجبة الأساسية وهو مجموعة الكنترول السالبة بينما المجموعة الثانية غذيت على الوجبة الغذائية الدهنية المكونة من الوجبة الأساسية + 10 % دهون حيوانية لمدة شهرين وبعد ذلك تم تقسيم هذه المجموعة الرئيسية الثانية إلى أربع مجموعات فرعية بموجب 8 فئران لكل مجموعة كالتالي : المجموعة الفرعية (1) هي مجموعة الكنترول الموجب الأولى التي تغذت على الوجبة الغذائية الدهنية ، أما بالنسبة للمجموعات الفرعية (2 ، 3 ، 4) هي التي غذيت على الوجبة الدهنية الغذائية المضاف إليها 20% (لتفاح او الكيوي أو خليط منهما) على التوالي .

أوضحت النتائج وجود زيادة معنوية فى الوزن لمجموعات الكنترول الموجبة التي غذيت على الدهون والمصابة بالبدانة وأيضاً زيادة فى مستويات الدهون والكوليسترول والجليسريدات الثلاثية وإنزيمات الكبد ووظائف الكلى مقارنة بمجموعة الكنترول السالبة . بينما أظهرت النتائج أن الفئران التي تغذت على الوجبة الغذائية الدهنية المضاف إليها التفاح والكيوي والخليط من التفاح والكيوي انخفاض معنوي فى وزن الجسم ومستويات الدهون الكلية والكوليسترول والجليسريدات الثلاثية واللليبوبروتين منخفض الكثافة الضار وإنزيمات الكبد ووظائف الكلى بينما أوضحت حدوث زيادة في مستوى اللليبوبروتين مرتفع الكثافة النافع. وأوضحت الدراسات الهستوباثولوجية كثيراً من التغيرات فى خلايا الكبد والكلى والقلب والمخ للفئران .

الكلمات المفتاحية : الدهون – البدانة – التفاح – الكيوي .