Effect of Bioactive Compounds of Avocado (Persea Americana) Fruit Powder on Hypercholesterolemic Rats: Biological and Biochemical Studies

Amal N. Z.Nasef¹, Asmaa. H. Ahmed²

ABSTRACT

This study was conducted to show the effect of different concentrations of avocado powder on some biological and biochemical parameters of hypercholesterolemic rats. Thirty male Sprague Dawley rats weighing between (180 ± 20g B.Wt) were divided into two main groups. The first main group (6 rats) was fed on basal diet as (control negative group –ve), while the second main group (24 rats) was classified into four groups (6 rats each) was fed on 1.5 % cholesterol plus 10% sheep tail for 15 days to induce hypercholesterolemia. One of these group was considered (control positive group +ve) and the other groups were fed 10% ,15% and 25% avocado powder, respectively, for 28 days. The chemical composition and bioactive compounds of avocado fruit were determined. The biological parameters as (BWG, FER, and FI and weight of internal organs) determined and biochemical parameters as (lipid profile, liver function, kidney function) and histological examination of heart, liver and kidney were performed. The results indicated that there was a significant increase in lipid profile except HDL, liver function and kidney function in the control (+ve ) group. It can be noted that all treatments of avocado powder improved the previous parameters. The best treatment was observed in the group fed on 25% avocado powder.

Keywords: Avocado- Hypercholesterolemic- biological, biochemical parameters- lipid profile- bioactive compounds.

INTRODUCTION

Cholesterol is an essential substance with several physiological functions; however, when its level elevates substantially in the blood (hypercholesterolemia) that leads to various deleterious conditions such as atherosclerosis and related cardiovascular diseases (CVD) (Roman et al., 2015).

Familial hypercholesterolemia (FH) is caused by a co-dominantly inherited defect in the synthesis or function of the LDL receptor (LDLR) that reduces the catabolism of LDL particles and markedly increases plasma cholesterol concentrations (Haralambos et al., 2016).

Hypercholesterolaemia is one of the major causes of atherosclerosis, although there are many causes, hypercholesterolaemia is the permissive factor that allows other risk factors to operate and the incidence of coronary heart disease is usually low where population plasma cholesterol concentrations are low (Aljenedil et al., 2018).

Avocado (Persea americana) is highly nutritious fruit, having curative effects for many human ailments, from diarrhea to high blood pressure due to assortment of vitamins, high in monounsaturated fat and potassium (Hamouda et al., 2016).

Avocado has low sugar content (0.2 g in a half unity). D-mannohexulose is the main kind of sugar found in the fruit which seems to lack nutritional properties, appearing to be one more phytochemical component of the avocado (Wang et al., 2015).

The Persea americana fruit was most effectively improved liver functions and antioxidant system and had an important phenolic and flavonoid compound (Mahmoud and Rezq, 2013).

Avocado had low caloric and a lot of fiber, 75% of fiber's avocado contents are considered insoluble and 25% are soluble so that avocado may improve hypercholesterolemia and may be useful in the treatment of hypertension and type 2 diabetes mellitus, avocado plays an important role in the cardiovascular health (Weschenfelder et al., 2015).

This research was undertaken to avocado is one of bioactive fruit has a high amount of flavonoids, phenolic compounds and vital minerals has appositive effects on metabolic and improve liver and kidney functions, hypercholesterolemic and cardiovascular.

MATERIALS AND METHODS

A- Materials:

- Fresh avocado fruits used in this study were purchased from the local market Shiben El-Kom City Menoufia Government, Egypt.

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• Cholesterol, was purchased from sigma Chemical Co. Casein, cellulose, and choline chloride powder were obtained from Morgan Co, Cairo, Egypt.
• Animals: Thirty mature male albino rats of Sprague-Dawley strain weighing between 180± 20 g., were obtained from Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt.

B- Methods:
Preparation of Avocado:
Avocado fruits were washed with running water. Then they have been carefully refined to get the edible part, and it was cut to thin slices then minced and sun dried, flowed by milling and kept in polyethylene bags at freezing temperature until using.

Experimental design
Thirty mature male albino rats of Sprague-Dawley strain weighing between 180± 20 g B.Wt., were used. The rats were divided into 5 groups (n=6) one of them used as control -ve while other groups had given 1.5% cholesterol plus 10% sheep tail for 15 days according to Ain (1993). as a positive +ve group and the other groups fed three doses of avocado powder (10.15 and 25%) for each treatment for 28 days.

Collection of samples
At the end of the experiment period, blood samples were collected after 12 h fasting from the portal vein; the rats were sacrificed under ether anesthesia. Blood samples were received into clean dry centrifuge tubes and left to clot at room temperature, then centrifuged for 10 min at 3000 rpm to separate the serum. Serum was carefully aspirated and transferred into clean covet tee tubes and stored frozen at -20°C for analysis (Malhotra, 2003).

Determination of chemical composition and bioactive compounds of avocado: Moisture, protein, fat, fiber, ash and minerals were determined according to AOAC (2012). Carbohydrate was calculated by difference. Identification of phenolic compounds were assessed by HPLC according to the method determined outlined by Radovanović et al. (2010).

Determination of some Biological parameters
During the experimental period, the diet consumed was recorded every day, and body weight recorded every week. The body weight gain (BWG) and feed efficiency ratio (FER) were determined according to Champman et al. (1959) using the following equations.

\[
\text{B.W.G. } \% = \frac{(\text{Final weight} - \text{Initial weight}) \times 100}{\text{Initial weight}}
\]

\[
\text{FER} = \frac{\text{Body weight gain (g/day)}}{\text{Feed intake (g/day)}}
\]

Determination of some biochemical parameters
The levels of serum creatinine and urea were estimated according to the method of Jendrassik and Grof (1983), respectively. Serum levels of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were assayed by the methods of Srivastava et al. (2002), and Chawla (2003), respectively. The serum levels of total cholesterol (TC), triglyceride (TG) and high-density lipoprotein (HDL-c) were determined by methods of Allain et al. (1974), Fossati and Prencipe (1982) and Demacker et al. (1980), respectively. The determination of low-density lipoprotein cholesterol (LDL-c), very low-density lipoprotein cholesterol (VLDL-c) and Atherogenic Index (AI) were carried out according to the methods of Lee and Nieman (1996) as follows:

\[
\text{LDL-c} = \text{Total cholesterol} - (\text{HDL-c} + \text{VLDL-c})
\]

\[
\text{VLDL-c} = \frac{\text{TG}}{5}
\]

\[
\text{Atherogenic Index (AI)} = \frac{\text{LDL} + \text{VLDL}}{\text{HDL}}
\]

Histopathology examinations:
Small specimens of the organs heart, liver and kidney were taken from each experimental group, fixed in neutral buffered formalin, dehydrated in ascending concentration of ethanol (70, 80 and 90%), cleared in xyylene and embedded in paraffin. Sections of 4–6 µm thickness were prepared and stained with hematoxylin and eosin according to Bancroft and Gamble (2008).

Statistical analysis:
The results are recorded as mean ± SD . Data were subjected to analysis of variance (ANOVA) for a completely randomized design using a statistical analysis system S.A.S (2000). Duncan’s multiple range tests were used to determine the differences among means at the level of 95%.

RESULTS AND DISCUSSION

Proximate chemical composition of avocado powder.
Proximate chemical composition of avocado powder is recorded in Table (1). The chemical components of avocado powder were 6.6,31,49,04,8,74,22,68 and 7.23 g/100g, for moisture, protein, fat, ash, fiber and carbohydrate, respectively. These results are in agreement with Alghamdi and Yousef, (2017). Also, Weschenfelder et al. (2015) reported that avocado was higher in fat and MUFAs.
Mineral contents of avocado powder (*persea Americana*).

The data in Table (2) show some mineral content of avocado powder. Avocado powder contained many important minerals as magnesium, manganese, calcium, iron, sodium, zinc and phosphorus. The highest mineral content of avocado was recorded for magnesium, calcium and sodium. They were 3318.341.50 and 809 mg/kg, respectively. The results obtained in the present study are high in Mg, Na and Zn and lower in phosphorus than that found by Weschenfelder *et al.* (2015).

Identification and determination of phenolic content of avocado powder extract.

Phenolic compounds of avocado powder are shown presented in Table (3).

Twenty-one compounds of phenolics were identified in dried avocado powder extract. Catechin and caffeic acid were the dominant being 80403 and 60314.4 ppm, respectively. They followed by α-amino benzoic acid and protocatchoic (29380 and 20198 ppm), respectively.

According to Mahmoud and Rezq (2013) ferulic acid and salicylic acid were lower in avocado phenolic acid since it was found to contain than less content in our results of the present study. Whereas Shehata and Soltan, (2013) reported that pyrogallol was the major compound of phenolic followed by ellagic and lowest in coumarin.

Effect of Avocado powder "AP" on feed intake (g/day), body weight gain (%) and food efficiency ratio (g) of hypercholesterolemic rats.

Body weight gain (B.W.G%), feed intake (F.I), and food efficiency ratio (F.E.R) of all hypercholesterolemic treated groups are illustrated in Table (4). Mean values

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**Table 1. Proximate chemical composition (%) of avocado powder on dry weight basis**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fiber</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avocado Powder</td>
<td>6</td>
<td>6.31</td>
<td>49.04</td>
<td>8.74</td>
<td>22.68</td>
<td>7.23</td>
</tr>
</tbody>
</table>

**Table 2. Mineral content of avocado powder (mg/kg) on dry weight basis**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mg</th>
<th>Mn</th>
<th>Ca</th>
<th>Fe</th>
<th>Na</th>
<th>Zn</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avocado Powder</td>
<td>3318</td>
<td>12.40</td>
<td>341.50</td>
<td>58.00</td>
<td>809</td>
<td>24.40</td>
<td>33.24</td>
</tr>
</tbody>
</table>

**Table 3. contents of individual phenolic compounds of dried avocado powder extract**

<table>
<thead>
<tr>
<th>Identified constituents</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catechol</td>
<td>63.76</td>
</tr>
<tr>
<td>Caffeic acid</td>
<td>60314.4</td>
</tr>
<tr>
<td>Vanillyl acid</td>
<td>46.5</td>
</tr>
<tr>
<td>3,4,5 methoxy cinnamon</td>
<td>311.43</td>
</tr>
<tr>
<td>Catechin</td>
<td>80403</td>
</tr>
<tr>
<td>Protocatechoic</td>
<td>20198</td>
</tr>
<tr>
<td>Ferulic acid</td>
<td>10.78</td>
</tr>
<tr>
<td>Coumarin</td>
<td>4.215</td>
</tr>
<tr>
<td>β-hydroxyl benzoic acid</td>
<td>10.93</td>
</tr>
<tr>
<td>Chlorogenic acid</td>
<td>14.71</td>
</tr>
<tr>
<td>α - amino benzoic acid</td>
<td>29380</td>
</tr>
<tr>
<td>Pyrogallol</td>
<td>28.02</td>
</tr>
<tr>
<td>Salicylic acid</td>
<td>54.085</td>
</tr>
<tr>
<td>α - coumaric acid</td>
<td>94.37</td>
</tr>
<tr>
<td>Ellagic acid</td>
<td>9.75</td>
</tr>
<tr>
<td>Benzoic acid</td>
<td>32.95</td>
</tr>
<tr>
<td>Oluropen</td>
<td>3.764</td>
</tr>
<tr>
<td>e- vanillic acid</td>
<td>567.3</td>
</tr>
<tr>
<td>Gallic acid</td>
<td>11.32</td>
</tr>
<tr>
<td>Epi-catechin</td>
<td>19.56</td>
</tr>
<tr>
<td>Qurestin</td>
<td>88.61</td>
</tr>
</tbody>
</table>
of BWG (%) and FER(g) of hypercholesterolemic treated group with 25% AP were significantly lower (P≤0.05) when compared to the corresponding values in hypercholesterolemic treated groups with 10 and 15 % AP respectively, and when compared with the control positive group (P≤0.05). This may be related to a high amount of fiber contained in avocado. But, mean value of FI (g/day) of hypercholesterolemic treated groups with 10, 15% and 25% AP, respectively showed no significant differences among them. (p≤0.05).

Naveh et al. (2013) and Fulgoni et al. (2013) indicated that avocado consumption is associated with improved nutrient intakes and lower body weight and reducing the risk of metabolic syndrome. While, Barakat (2011) showed that avocado decreased significantly FER as compared to +v group.

**Effect of avocado powder "AP" on serum lipid profile (TC, TG, HDL-C, LDL-C - VLDL-C and AI) of hypercholesterolemic rats.**

The impact of avocado powder on lipid profile of hypercholesterolemic rats is presented in Table (5). Rats fed on high fat diet and levels of cholesterol without any addition showed significant increase (P ≤ 0.05) in the levels of serum cholesterol, triglyceride, very low density lipoprotein cholesterol (VLDL-c), low density lipoprotein cholesterol (LDL-c) and atherogenic index (AI) compared with the normal control group while, high density lipoprotein cholesterol (HDL-c) had an opposite trend.

These increase in TC, TG, LDL-c, VLDL-c and AI in hypercholesterolemic rats may be related to fed the rats on 1.5 % cholesterol plus 10% sheep tail for 15 days to induce hypercholesterolemia which leading to the accumulation of lipid on blood.

The data in the same Table showed significant reduction (p ≤ 0.05) in TC, TG, LDL-C, VLDL-C and AI levels and elevation in the level of HDL-C compared with the positive control group. This decrement could be attributed to antioxidant capacity in avocado powder which is rich in polyphenols (flavonoids and phenolic acids). Also, the results indicated that supplementation hypercholesterolemic rats with 25% of avocado powder was more effective (P ≤ 0.05) in reducing TC, TG, LDL-C, VLDL-C and AI than those supplemented with 10 and 15 %, AP.

These results are in agreement with those obtained by Mohammed (2011) who revealed that the avocado

### Table 4. The effect of avocado powder "AP" on feed intake (g/day), body weight gain(%) and food efficiency ratio (g) of hypercholesterolemic Rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Feed Intake (g/day)</th>
<th>BWG(%)</th>
<th>FER (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 Control (-)</td>
<td>16.9±0.3b</td>
<td>22.17±0.02b</td>
<td>0.041±0.002b</td>
</tr>
<tr>
<td>G2 Control (+)</td>
<td>19.7±0.5b</td>
<td>36.73±0.12a</td>
<td>0.072±0.001a</td>
</tr>
<tr>
<td>G3 (10 %AP)</td>
<td>17.3±0.31b</td>
<td>6.21±0.07d</td>
<td>0.014±0.002d</td>
</tr>
<tr>
<td>G4 (15 %AP)</td>
<td>17.9±0.1b</td>
<td>6.88±0.05ed</td>
<td>0.016±0.002c</td>
</tr>
<tr>
<td>G5 (25%AP)</td>
<td>18±0.3b</td>
<td>4.81±0.01c</td>
<td>0.011±0.001c</td>
</tr>
</tbody>
</table>

All results are expressed as mean ± SD. Values in each column which have different superscript letters are significantly different at P≤0.05.

* BWG: Body Weight Gain  FI: Feed Intake  FER: Food Efficiency Ratio

### Table 5. The effect of avocado powder "AP" on serum lipid profile (TC ,TG, HDL-C, LDL-C - VLDL-C and AI) of hypercholesterolemic rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>TC Mg/dl</th>
<th>TG Mg/dl</th>
<th>HDL-c Mg/dl</th>
<th>LDL-c Mg/dl</th>
<th>VLDL-c Mg/dl</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 Control (-)</td>
<td>89.96±2d</td>
<td>50.8±2.1d</td>
<td>65.6±1.1a</td>
<td>14.16±2.3d</td>
<td>10.16±0.4cd</td>
<td>0.36±0.035c</td>
</tr>
<tr>
<td>G2 Control (+)</td>
<td>140±2.3a</td>
<td>118.6±24a</td>
<td>24.4±2.7d</td>
<td>91.8±3a</td>
<td>23.7±0.4a</td>
<td>4.78±0.64a</td>
</tr>
<tr>
<td>G3 (10 %AP)</td>
<td>124.2±2c</td>
<td>71.4±2.5b</td>
<td>57±1.3c</td>
<td>52.9±3c</td>
<td>14.28±0.5b</td>
<td>1.17±0.01b</td>
</tr>
<tr>
<td>G4 (15 % AP)</td>
<td>131.01±0.33b</td>
<td>62.8±2.3c</td>
<td>60.2±1.3b</td>
<td>58.2±2.1b</td>
<td>12.56±0.4c</td>
<td>1.17±0.2b</td>
</tr>
<tr>
<td>G5 (25%AP)</td>
<td>126.4±0.63c</td>
<td>51±1.5d</td>
<td>58.3±0.9b</td>
<td>57.9±2b</td>
<td>10.2±0.3cd</td>
<td>1.16±0.2b</td>
</tr>
</tbody>
</table>

All results are expressed as mean ± SD. Values in each column which have different superscript letters are significantly different at P≤0.05.

pulp at doses of 1 and 2 ml/day/rat caused a significant decrease in the serum lipid including TC and TG levels but showed significant increase in HDL-c. Also, Wang et al. (2015) found that the diet rich in avocado had effects on serum cholesterol level. Additionally, Dreher and Adrienne (2013) showed that the avocado had the highest fruit lipophilic antioxidant capacity, which reduced the serum lipid peroxidation and promoting vascular health. Also, Boshtam et al. (2013) found that avocado may modify the structure of the HDL lipoprotein by increasing paraoxonase1 (PON1) enzyme activity, the cardio protector effect of HDL-cholesterol is in part due to PON1 activity, which is responsible for the hydrolysis of lipid hydroperoxides (products of the lipid oxidation).

Effect of avocado powder "AP" on liver functions (AST-ALT and AST/ALT u/l) of hypercholesterolemic rats.

The impact of avocado powder on liver functions of hypercholesterolemic rats is presented in Table (6). The effect of avocado powder on AST, ALT and AST/ALT of the hypercholesterolemic rats showed that the mean value AST, ALT and AST/ALT of the control (+) group were higher than those of the control (-) group being 154±6.10, 49.61±0.7 and 3.10±0.08 u/l respectively, this may be revealed to a high levels of cholesterol which can cause heart disease. They also overloaded the liver leading to fatty liver and liver damage. On the other hand, supplementation of hypercholesterolemic rats with avocado powder can alleviate the serum levels of AST, ALT and AST/ALT as well as these enzymes levels showed decreasing tendency with increasing doses of avocado powder whereas supplementation of hypercholesterolemic rats with 25% avocado powder decreased the serum levels of AST, ALT and AST/ALT by (57.8±1.3, 30.12±1.2 and 1.91±0.12 u/l) respectively comparing with the positive control group.

The result obtained in Table (6) agreed with Mahmoud and Rezq (2013) they reported that administration of variety concentration level of dried avocado caused lower of serum AST and ALT content compared to (+ve) . Also, Mohammed (2011) indicated that rats which consumed 1 or 2 ml/day avocado extract showed a decrement in Ast and Alt activity compared to +ve group. In addition, Al-Dosari (2011) found that feeding on high cholesterol diet with avocado fruit resulted in significant decrement in liver function enzymes.

Effect of avocado powder "AP" on kidney functions (serum creatinine and urea) mg/dl of hypercholesterolemic rats.

The impact of avocado powder on kidney functions of hypercholesterolemic rats are shown in Table (7). Serum creatinine and urea levels were significantly lowering in the positive control group rats as compared to those of the control negative group. The increase in the level of creatinine and urea could be due to the cause of the renal dysfunction resulting from exposure to cholesterol and high fat diet.

On the other hand, the results indicated that there were significant decrease (P≤0.05) in the level of creatinine and urea in hypocholeserolic rats treated with avocado powder (AP) when compared with (+ve) group and this decrease in the level of creatinine and urea showed an increasing inclination with increasing dose of (AP). This improvement in renal functions may be due to antioxidants and phenolic compounds present in avocado which protect against renal injury. Also, the lowest level of creatinine and urea in hypercholesterolemic rats were obtained with the group fed 25% of AP.

Table 6. The effect of avocado powder "AP" on liver functions (AST- ALT and AST/ALT u/l )of hypercholesterolemic rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Parameters</th>
<th>AST</th>
<th>ALT</th>
<th>AST/ALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 Control (+)</td>
<td>49.31±1.01&lt;sup&gt;e&lt;/sup&gt;</td>
<td>19.1±0.5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.58±0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>G2 Control (+)</td>
<td>154±6.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.61±0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.10±0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>G3 (10 % AP)</td>
<td>75.33±2.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36.3±2.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.07±0.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>G4 (15 % AP)</td>
<td>64.1±1.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>41.98±0.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.52±0.06&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>G5 (25%AP)</td>
<td>57.8±1.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>30.12±1.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.91±0.12&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

All results are expressed as mean ± SD.
Values in each column which have different superscript letters are significantly different at p≤0.05.
Table 7. The effect of avocado powder "AP" on kidney functions (serum creatinine and urea) of hypercholesterolemic rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Parameters</th>
<th>S. creatinine Mg/dl</th>
<th>Urea Mg/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 Control (-)</td>
<td></td>
<td>0.7±0.02 e</td>
<td>26.2 ±1 d</td>
</tr>
<tr>
<td>G2 Control (+)</td>
<td></td>
<td>1.6±0.01 a</td>
<td>65.11±0.55 a</td>
</tr>
<tr>
<td>G3 (10 %AP)</td>
<td></td>
<td>0.97±0.03 b</td>
<td>62.1±0.5 b</td>
</tr>
<tr>
<td>G4 (15 % AP)</td>
<td></td>
<td>0.91±0.01 d</td>
<td>52.9±1 c</td>
</tr>
<tr>
<td>G5 (25%AP)</td>
<td></td>
<td>0.93±0.01 c</td>
<td>52.21±0.5 c</td>
</tr>
</tbody>
</table>

All results are expressed as mean ± SD. Values in each column which have different superscript letters are significantly different at P≤0.05.

In this respect, the elevated level of urea in rats fed on high fat diet is likely due to the increase of amino acid catabolism which impaired kidney function or liver damage (Lietyz and Finley, 1983). The results obtained in the present study agreed with Alghamdi and Yousef (2017). They showed that rat fed on diet fortified with avocado reducing kidney function compared with the positive control group.

Histopathological examination

Liver:

Microscopically, liver of the control (-) rat revealed the normal liver structure, central vein, hepatic sinusoids and hepatocytes (photo1). Meanwhile, liver of the control (+) rat showed multiple fat globules in hepatic sinusoids and vacuolar degeneration in hepatocytes cytoplasm, dilated sinusoids engorged with blood and contain multiple fat globules in addition to vacuolar degeneration in some hepatic cells and few inflammatory cells infiltration (photo 2,3). Examined sections of rat from 10% avocado powder, 15% avocado powder and 25% avocado powder group revealed no histopathological changes (photos 4,5,6).

Kidney:

Microscopically, kidneys of the control (-) rat the revealed the normal histological structure of renal parenchyma (photo 7).

Photo 1. Liver of control (-) rat group showing normal liver structure, central vein, hepatic sinusoids and hepatocytes (H and E X400)

Photo 2. Liver of control (+) rat group showing multiple fat globules in hepatic sinusoids and vacuolar degeneration in hepatocytes cytoplasm (H and EX 400)

Photo 3. Liver of control (+) rat group showing dilated sinusoids engorged with blood and contain multiple fat globules in addition to vacuolar degeneration in some hepatic cells and few inflammatory cells infiltration (H and EX400)
Photo 4. Liver of rat from 10% avocado powder group showing no histopathological changes (H and EX 400)

Photo 5. Liver of rat from 15% avocado powder group showing no histopathological changes (H and EX 400)

Photo 6. Liver of rat from 25% avocado group showing no histopathological changes (H and EX 400)

Photo 7. Kidney of control (-) rat group showing the normal histological structure of renal parenchyma (H and E X 400)

Photo 8. Kidney of control (+) rat group showing vacuolar degeneration of epithelial lining renal tubules (H and E X 400)

Photo 9. Kidney of rat from group 15% avocado powder group showing no histopathological changes (H and E X 400)

Photo 10. Kidney of rat from 25% avocado powder group showing no histopathological changes (H and E X 400)

Meanwhile, kidneys of the control (+) rat showed vacuolar degeneration of epithelial lining renal tubules and interstitial nephritis (photos 8). However, kidneys of rats from 15% avocado powder group, 25% avocado group revealed no histopathological changes (photos 9,10). Some examined sections from 10% avocado powder group showed congestion of renal blood vessels, vacuolar degeneration of epithelial lining renal tubules (photos 11).
Photo 11. Kidney of rat from 10% avocado powder group showing dilatation and congestion of renal blood vessels (H and E X 400)

Photo 12. Heart of the control (-) rat showing normal cardiac muscle fibers (H and E X 400)

Photo 13. Heart of the control (+) rat showing vacuolar degeneration in the cytoplasm of cardiac muscle fibers and congestion in cardiac blood vessels (H and EX400)

Photo 14. Heart of the control (+) rat showing sever hyaline degeneration in cardiac muscle fibers and fat globules in cardiac blood capillaries (HandEX400)

Photo 15. Heart of rat from 15 avocado powder group showing no histopathological changes (HandEX400)

Photo 16. Heart of rat from 25% avocado powder group showing no histopathological changes (Hand EX400)

Heart:

Microscopically, heart of the control (-) rat revealed the normal cardiac muscle fibers (photo12). Meanwhile, heart of control (+) rat showed vacuolar degeneration in the cytoplasm of cardiac muscle fibers, congestion in cardiac blood vessels and sever hyaline degeneration in cardiac muscle fibers, fat globules in cardiac blood capillaries (photos 13 and 14). However, heart of rats from 15% avocado powder, 25% avocado powder group revealed no histopathological changes (photos 15,16). Some examined sections from 10% avocado powder group showed vacuolar degeneration in cytoplasm of muscle fibers, mild degeneration in cardiac muscle fibers and few hyaline degeneration in cardiac muscle fibers (photos 17).

CONCLUSION:

Avocado is one of bioactive fruit has a high amount of flavonoids, phenolic compounds and vital minerals has appositive effects on metabolic factories and medicines, and has the capability to decline total cholesterol, triglycerides, LDL-c and increased HDL-c. At the same time, improve the functions of liver and kidney.

REFERENCES


تأثيرات المركبات النشطة حيويًا لمسحوق ثمار الأفوكادو على الفئران المصابة بارتفاع الكوليسترول: دراسة بيولوجية وكيميويّة

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هذِه الدراسة توضَّح تأثير التركيزات المختلفة من مسحوق ثمار الأفوكادو على المراقبات البيولوجية والكيميويّة لمرض ارتفاع الكوليسترول. تم استخدام 30 فائراً من الذكور من النوع الالبينو تتراوح أوزانهم بين 200±180 جم، تم تقسيمهم إلى مجموعتين رئيسيتين: المجموعة الأولى (6 فائرون) تغذت علي الغذاء الأساسي (المجموعة الضابطة السالبة) والمجموعة الرئيسية الثانية (24 فائراً تم تقسيمهم إلى أربع مجاميع) (6 فائرون لكل مجموعة). تم تغذيتهم على تركيزات مختلفة من مسحوق الأفوكادو (10%, 15% و 25%) على التوالي لمدة 28 يوم. في نهاية التجربة تم قياس التركيب الكيميائي والمراقبات الفعالة لدواء الأفوكادو وقياس المؤشرات البيولوجية (DWG - FER - FI - BWG) والكلمات الدالة: الأفوكادو - ارتفاع الكوليسترول- التغيرات البيولوجية - الكيميويّة - دهون الدم - النشط حيويًا.

الكلمات الدالة: الأفوكادو - ارتفاع الكوليسترول - التغيرات البيولوجية - الكيميويّة - دهون الدم - النشط حيويًا.