Anti-obesity Effect of Flax Seed (Linum usitatissimum) and Avocado (Persea Americana) on Induced Obese Rats

Emad M. El-Kholie, Tarek M. Abd El-Rahman and Amira A. Hamouda

Nutrition & Food Science Dept., Faculty of Home Economics, Menoufia Univ., Egypt.

Abstract

The effect of different concentrations (2.5&5%) as powder of avocado, flax seed and their mixture as powder on obese rats were evaluated. Forty eight male albino rats weighting 140 ±10 g were used in this study and divided into 8 groups, each group contain 6 rats. Rats were treated by high fat diet (20% animal fat) to induce obese. Results showed that the highest body weight gain, feed intake and feed efficiency ratio recorded for (5%) mixture of avocado and flax seed powder, while the lowest recorded for avocado fruits powder (2.5%) with significant difference. The lower ALT, AST liver enzyme, cholesterol and triglycerides levels of treated group recorded for group fed on mixture of avocado fruits and flax seed powder (5%) with significant difference. The highest (HDL-c) levels recorded for group fed on mixture of avocado fruits and flax seed powder (5%). The lowest LDL-c and VLDL-c values recorded for group fed on (5%) mixture with significant difference. While, the lowest uric acid, urea and creatinine values recorded for group fed on (5%) mixture of avocado fruits and flax seed powder with significant difference. As conclusion, obese rats treated with (5%) mixture of avocado fruits and flax seed powder had improvement lipid profile and liver functions compared with (2.5%) avocado fruits powder.

Key words: Avocado fruits, Fax seed, Rats, Anti-obesity and Biochemical analysis.

Introduction:

Obesity is the most prevalent health problem. It is also known to be a risk factor for the development of metabolic disorders such as type 2 diabetes, systemic hypertension, cardiovascular disease, dyslipidemia, and atherosclerosis. Obesity is a pathological condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems (Cheng et al., 2010).

Hassan and El-Gharib, (2015) concluded that obesity is becoming one of the most prevalent health concerns among all populations and age groups worldwide, resulting in a significant increase in mortality and morbidity related to coronary heart diseases, diabetes type 2, metabolic syndrome, stroke, and cancers. Disappointing results after cessation the
lifestyle modification or pharmacotherapy compelled the researchers and physicians to rethink to find a new, safe, and striking therapeutic alternative for this global health concern. Many natural products act as anti-obesity through various mechanisms to reduce body weight and its complications.

Also, obesity is generally defined as the abnormal or excessive accumulation of fat in adipose tissue to the extent that health may be impaired (Aronne and Segal, 2002).

Flaxseeds (Linum usitatissimum, L.), scientifically known as Linum usitatissimum, L. belong to Linaceae family, Flaxseed is rich in fat, protein, dietary fiber and antioxidants. Flax seeds may constitute a good source of healthy compounds, useful in the prevention of diseases (Ganorkar and Jain, 2013).

Flax seed is used as a food source and has many valuable nutritional qualities. Flaxseed has potential health benefits besides the nutrition, due to mainly 3 reasons: first, due to its high content of ω-3 αlinolenic acid; Second, being rich in dietary soluble and insoluble fibers; and third, due to its high content of lignans, acting as anti-oxidants and phytoestrogens. ALA can be metabolized in the body into docosahexaenoic acid (DHA) (ω-3) and eicosapentaenoic acid (EPA) (ω-3). The health benefits of all ω-3 fatty acids (ALA, EPA and DHA) have been widely reported for several conditions including cardiovascular diseases, kidney failure and blindness. A positive correlation was reported between the raised blood glucose level and the risk of cardiovascular diseases (Boden-Albala et al., 2008).

Flaxseeds have cholesterol lowering effect as cholesterol is surrounded by the gel formation because of soluble fiber content of flaxseed which inhibits cholesterol absorption and leads to more excretion of cholesterol. Moreover, diabetes was tends to occur together with other risk factors such as obesity, hypertension, low HDL cholesterol and a high triglyceride level (Bernacchia et al., 2014).

The avocado (Persea americana) is a tree, long thought to have originated in South Central Mexico, classified as a member of the flowering plant family Lauraceae. The fruit of the plant, also called an avocado (or avocado pear or alligator pear), is botanically a large berry containing a single large seed (Anon, 2010).

Avocado is known as a super food. It provides healthy nutrients to the body. However, avocado seed contained nearly 20 vitamins and minerals. In addition, it is high in unsaturated fats (75%) such as monounsaturated and polyunsaturated fats. These notations may partially influence the feed
intake and growth performances, particularly when the effects appeared to be dose dependent (Leite et al., 2009).

The avocado fruit has a lot of nutrients. This includes its high content of essential minerals, potassium, vitamin b6, vitamin E and B complex. The avocado seed also contains various classes of natural products such as phytosterols and triterpenes, fatty acids with olefinic, acetylenic bonds, furanoic acid, dimmers of flavonols and oligomeric proanthocyanidins, β-d-glucoside of 8-hydroxyabscisic acid and epidihydrophaseic acid β-d-glucoside. Studies have shown that avocado can be used to reduce visceral fat accumulation and improve hyperlipidemia and hyperglycaemia in rat. In addition, the consumption of avocado based diets showed lower cholesterol levels (Gouegni and Abubakar, 2013).

This work was conducted to study the effect of avocado, flax seed and their mixture powder on biochemical analysis of obese rats.

Material and Methods:

Materials:

Flax seed (Linum usitatissimum) and avocado (Persea americana) fruits were obtained from local market, Cairo Governorate, Egypt.

The induction of experimental obesity:

Obesity was induces in normal healthy male albino rats by fed on high fat diet (20% animal lipid) supplemented in the basal diet and used as a positive control group.

Casein, cellulose, choline chloride, and DL- Methionine:

Casein, cellulose, choline chloride powder, and DL- methionine powder, were obtained from Morgan Co. Cairo, Egypt.

Experimental animals:

A total of 48 adult normal male albino rats Sprague Dawley strain weighing 140±10 g were obtained from Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt.

The chemical kits:

Chemical kits used for determination the (TC, TG, HDL-c, ALT, AST, urea, uric acid and creatinine) were obtained from Al-Gomhoria Company for Chemical, Medical and Instruments, Cairo, Egypt.
Methods:

Preparations of avocado fruits and flax seed:

To prepare the avocado fruits and flax seed was obtained from local market. Fruits of avocado were purchased in April, 2017. Avocado fruits were washed thoroughly under running tap water. Samples were collected, dried in air oven dryer at 50 ºC and grinded to powder form. While, were obtained at dried form, and then milled to obtain powder form. Also flax seeds were grinded to obtain the powder.

Experimental design:

Forty eight adult male white albino rats, Sprague Dawley Strain, 10 weeks age, weighing (140±10g) were used in this experiment. All rats were fed on basal diet (casein diet) prepared according to AIN, (1993) for 7 consecutive days. After this adaptation period, rats are divided into 8 groups, each group which consists of six rats as follows: group (I): rats fed on basal diet as negative control. Group (2): Obese rats induced by fed on high fat diet (20% animal lipid) supplemented in the basal diet and used as a positive control group. Group (3): A group obese rats fed on avocado fruit as powder by 2.5% of the weight of basal diet. Group (4): A group infected obese rats fed on avocado fruit as powder by 5% of basal diet. Group (5): A group infected obese rats fed on flax seed as powder by 2.5% of the weight of the rat. Group (6): A group infected obese rats fed on flax seed as powder by 5% of the weight of the rat. Group (7): A group infected obese rats fed on mixture of the avocado fruits and flax seed as powder by 2.5% of the weight of the rat. Group (8): A group infected obese rats fed on mixture of the avocado fruits and flax seed as powder by 5% of the weight of the rat.

During the experimental period, the body weight and feed intake were estimated weekly and the general behavior of rats was observed. The experiment period was take 28 days, at the end of the experimental period each rat weight separately then, rats are slaughtered and collect blood samples. Blood samples were centrifuged at 4000 rpm for ten minute to separate blood serum, and then kept in deep freezer till using.

Blood sampling:

After fasting for 12 hours, blood samples in initial times were obtained from retro orbital vein, while it obtained from hepatic portal vein at the end of each experiment. Blood samples were collected into a dry clean centrifuge glass tubes and left to clot in water bath (37°C) for 30 minutes, then centrifuged for 10 minutes at 4000 rpm to separate the serum, which were carefully aspirated and transferred into clean cuvette tube and stored.
frozen in deep freezer till analysis according to method described by Schermer (1967).

**Body weight gains (BWG), feed intake (FI), and feed efficiency ratio (FER):**

During the experimental period (28 days) the net feed intake was daily recorded, while body weight was weekly recorded. The net feed intake and gained body weight were used for the calculation of feed efficiency ratios (FER) according to Chapman et al., (1959) as follow:

\[
FER\% = \frac{\text{Bodyweight gain (g)}}{\text{Feed intake (g)}}
\]

**Biochemical analysis:**

**Lipids profile:**

**Determination of total cholesterol:**

Serum total cholesterol was determined according to the colorimetric method described by Thomas (1992).

**Determination of serum triglycerides:**

Serum triglyceride was determined by enzymatic method using kits according to the Young, (1975) and Fossati, (1982).

**Determination of high density lipoprotein cholesterol (HDL-c):**

HDL-c was determined according to the method described by Friedewald (1972) and Grodon and Amer (1977).

**Calculation of very low density lipoprotein cholesterol (VLDL-c):**

VLDL-c was calculated in mg/dl according to Lee and Nieman (1996) using the following formula:

\[
\text{VLDL-c (mg/dl)} = \frac{\text{Triglycerides}}{5}
\]

**Calculation of low density lipoprotein cholesterol (LDL-c):**

LDL-c was calculated in mg/dl according to Lee and Nieman (1996) as follows:

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

**Liver functions:**

Determination of serum alanine amino transferase (ALT), serum asparatate amino transferase (AST) were carried out according to the method of Haffkenscheid (1979), Clinica Chimica Acta (1980), and Moss (1982), respectively.
Kidney functions:

**Determination of serum urea and serum creatinine:**

Serum urea and serum creatinine were determined by enzymatic method according to Henry (1974) and Patton & Crouch (1977).

**Statistical analysis:**

The data were analyzed using a completely randomized factorial design (SAS, 1988) when a significant main effect was detected; the means were separated with the Student-Newman-Keuls Test. Differences between treatments of (P≤0.05) were considered significant using Costat Program. Biological results were analyzed by One Way ANOVA.

**Results and Discussion:**

**Effect of avocado, flax seed and their mixture on body weight gain, feed intake and feed efficiency ratio of obese rats:**

Data presented in Table (1) show the effect of avocado, flax seed and their mixture on body weight gain (BWG), feed intake (FI) and feed efficiency ratio (FER) of obese rats. The obtained results showed that the body weight gain (BWG) % of negative control recorded the highest value when compared with positive control with significant difference. The mean values were 29.0 and 19.40 %, respectively. From obese rats groups, it is clear to notice that the highest (BWG) % recorded for 5% mixture, while the lowest BWG% recorded for 2.5 % avocado fruit with significant difference (P≤0.05). The mean values were 39.40 and 22.0 %, respectively.

In case of feed intake, it could be notice that the feed intake (FI) gm/day of negative control recorded the highest value when compared with positive control with significant difference. The mean values were 19.02 and 16.97, respectively. While, 5% mixture recorded the highest FI while the lowest value recorded for 2.5 % avocado fruit with significant difference (P≤0.05). The mean values were 21.20 and 17.08, respectively.

On the other hand, feed efficiency ratio (FER) of negative control recorded the highest value when compared with positive control with no significant difference (P≤0.05). The mean values were 0.054 and 0.041 %, respectively. In case of treated rat groups, it clear to mention that 5% mixture recorded the highest FER while, the lowest value recorded for 2.5 % avocado fruit with significant difference. The mean values were 0.066 and 0.046 %, respectively. These results are in agreement with Khalesia et al. (2011), they found that rats consumption flaxseed was slightly lower in groups with higher percentage of (maybe due to the fact that flaxseed has high level of fat and fiber), no significant difference was observed between
the average feed intake between any treatment group and control group (p ≤ 0.05).

Avocado consumption is associated with improved nutrient intakes and lower body weight and possibly reducing the risk of metabolic syndrome. Moreover, the feed efficiency ratio of treated groups fed on hyperlipidimic diet with Avocado fruits at (15% or 25%) recorded significant decreased (P ≤ 0.05), as compared to control positive group, this data agree with Barakat, (2011), they reported that avocado seeds could have lowered the feed intake by SHR which resulted to lower weight gain. This suggested that there is an impaired assimilation of nutrients (reduced feed efficiency) from ingested feed by SHR when avocado seeds were added to the diet (Leite et al., 2009).

Effect of avocado, flax seed and their mixture on liver functions level of obese rats:

Data given in Table (2) show the effect of avocado, flax seed and their mixture on liver functions (AST and ALT) of obese rats. The obtained results indicated that the AST liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 252.50 and 110.50 U/L, respectively. While, the highest AST liver enzyme of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 224.5 and 131.0 U/L, respectively. In case of ALT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 83.50 and 50.50 U/L, respectively. While, the highest ALT liver enzyme of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 76.50 and 58.50 U/L, respectively. These results are in agreement with Al-Bashri (2013), who reported that flaxseed supplemented diet significantly lowered the plasma level of liver functional markers including ALT and AST in hypertensive rats.

Although ALT, AST and ALP enzyme values were reduced in the hypercholesterolemic rats fed different replacement levels of flaxseed oil, but their values were still higher (P≤0.05) than those values of the negative control rats. This may be referred into a direct excessive effect of feeding at high cholesterol diet on liver enzymes, at the same time; our results indicated that the high levels of AST and ALT in serum are
indicators for liver dysfunction. These findings are in agreement with Al-Dosari, (2011), who revealed that the rats feeding on high cholesterol diet for 70 day showed significant increase in serum liver marker enzymes (GOT, GPT, GGT, ALP) and bilirubin levels. Our data indicated also that, feeding on high cholesterol diet with Avocado fruit which used in the above fortifications at 15% & 25% resulted in significant decrease $p \leq 0.05$ in serum Aspartate aminotransferase and Alanine amino transferase (AST and ALT) as compared to positive control group.

**Effect of avocado, flax seed and their mixture on total cholesterol and triglycerides level of obese rats:**

The effect of avocado, flax seed and their mixture on the serum total cholesterol and triglycerides of obese rats are shown in Table (3). The obtained results indicated that the cholesterol levels of positive control group recorded the highest value when compared with negative control group with significant difference ($p \leq 0.05$). The mean values were 135.50 and 95.50 mg/dl, respectively. While, the lowest cholesterol levels recorded for group fed on 5% mixture while the highest value recorded for 2.5% flax seed with significant difference ($P \leq 0.05$). The mean values were 87.50 and 109.50 mg/dl, respectively.

On the other hand, the triglyceride of positive control group recorded the highest value when compared with negative control group with significant difference ($P \leq 0.05$). The mean values were 133.00 and 63.00 mg/dl, respectively. While, the lowest triglyceride recorded for group fed on 5% mixture while the highest value recorded for 2.5% flax seed with significant difference ($P \leq 0.05$). The mean values were 51.50 and 101.00 mg/dl, respectively. These results are in agreement with Cardozo et al., (2010), they observed a decrease in plasmatic concentrations of total cholesterol (TC) and triglycerides (TG) in mature rats that received flaxseed flour components via breast milk during lactation. Another study by Riediger et al., (2008), they reported that lowering of blood cholesterol as a result of avocado seeds inclusion in the diet may be due to the phenolic compounds such as phytosterols in a concentration of 826 mg/kg dry weight.

These phytosterols in particular the beta-sitosterols are known to induce a decrease in plasma lipoprotein and cholesterol levels by decreasing the cholesterol solubility and absorption across the intestinal barrier. This lowering effect is based on the fact that the higher phytosterols hydrophobicity is more readily to mix with bile salt and acid micelles than can animal cholesterol resulting in the
excretion with the faeces a greater part of unabsorbed cholesterol, particularly the low density lipoprotein.

Pouteau et al., (2003), reported that there was an increase in the cholesterol levels of SD tars fed on HSD containing avocado seeds. These changes may be attributed to animal variations in responses to the presence of avocado seeds since SD rats fed on HSD are expected to be hypercholesterolemic as demonstrated in other studies of animals fed on high sucrose diet.

Also the results of Sadava et al., (2011) show that the seed and leaf extracts of Persea americana brought about significant reduction in the plasma and liver cholesterol levels. A reduction in the level of cholesterol lowers the blood pressure and prevents cardiovascular disease. A report by Anderson reveals that Persea americana extracts would probably reduce hypertension, cardiovascular diseases, obesity and heart diseases by decreasing cholesterol levels (Brent). However it is reported also that the decrease in plasma cholesterol following administration of this extract can also affect metabolism of bile salts.

Effect of avocado, flax seed and their mixture on lipid profile level of obese rats:

The effect of avocado, flax seed and their mixture on serum lipid profile (HDL-c, LDL-c and VLDL-c) level of obese rats was shown in Table (4). The results indicated that the HDL-c of positive control rats group recorded the highest value when compared with negative control group with significant difference (P<0.05). The mean values were 45.00 and 26.50 mg/dl, respectively. While, the highest HDL-c of treated group recorded for group fed on 5% mixture but, the lowest value recorded for group fed on 2.5 % avocado fruits with significant difference (P≤0.05). The mean values were 39.10 and 28.00 mg/dl, respectively.

On the other hand, the LDL-c of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 82.40 and 37.90 mg/dl, respectively. While, the highest LDL-c of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group fed on 5 % mixture with significant difference (P≤0.05). The mean values were 59.30 and 38.10 mg/dl, respectively.

In case of VLDL-c, the positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 26.60 and 12.60 mg/dl,
respectively. While, the highest VLDL-c of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group fed on 5 % mixture with significant difference (P≤0.05). The mean values were 20.20 and 10.30 mg/dl, respectively. These results are in agreement with Prasad (2001), who reported that many studies have shown its positive effects of flax seeds when used as a supplemental feeding. These effects are manifested as improvement in lipid profile (HDL-c, LDL-c and VLDL-c), and controlling weight gain.

Fukumitsu et al., (2010) found that administered capsules of 20 mg or 100 SDG to moderately hypercholesterolemic men, daily during 12 weeks, observing significant results in decrease of LDL/HDL ratio in those ones who ingested 100 mg per day. Therefore avocado pear (Persea americana) reduces TC/HDL Ratio thereby boosting the “good cholesterol” (HDL) which is good for cardiovascular health (Olagunju et al., 2017).

**Effect of avocado, flax seed and their mixture on kidney functions level of obese rats:**

Data presented in Table (5) show the effect of avocado, flax seed and their mixture on the kidney functions (uric acid, urea and creatinine) level of obese rats. The obtained results indicated that the creatinine level of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 4.18 and 1.80 mg/dl, respectively. While, the highest creatinine level of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 3.49 and 1.94 mg/dl, respectively.

On the other hand, the urea level of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 48.5 and 25.40 mg/dl, respectively. While, the highest urea level of treated group recorded for group fed on 2.5 % flax seed but, the lowest value recorded for group
fed on 5% mixture with significant difference (P≤0.05). The mean values were 39.10 and 27.50 mg/dl, respectively.

In case of uric acid, the level of positive control rats group recorded the highest value when compared with negative control group with significant difference (P≤0.05). The mean values were 3.50 and 1.80 mg/dl, respectively. While, the highest uric acid level of treated group recorded for group fed on 2.5% avocado fruits but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 2.90 and 1.85 mg/dl, respectively. These results are in agreement with El-Sayed et al., (2014) they reported that flaxseed supplemented diet significantly lowered the plasma level of kidney functional markers including urea, uric acid and creatinine in hypertensive rats. Barakat and Mahmoud (2011) reported that feeding rats with cholesterol-enriched diet caused a significant increase in serum urea.

Table (1): Effect of avocado, flax seed and their mixture on body weight gain, feed intake and feed efficiency ratio of obese rats

<table>
<thead>
<tr>
<th>Parameters</th>
<th>BWG (g)</th>
<th>FI (g/day)</th>
<th>FER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
</tr>
<tr>
<td>Control group (-)</td>
<td>29.0 ± 0.40&lt;sup&gt;d&lt;/sup&gt;</td>
<td>19.02 ± 0.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.054± 0.11&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control group (+)</td>
<td>19.40 ± 0.20&lt;sup&gt;g&lt;/sup&gt;</td>
<td>16.97 ± 0.30&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.041± 0.13&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (2.5%)</td>
<td>22.0 ± 0.80&lt;sup&gt;f&lt;/sup&gt;</td>
<td>17.08 ±1.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.046± 0.12&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (5%)</td>
<td>26.20± 0.60&lt;sup&gt;e&lt;/sup&gt;</td>
<td>18.75 ±0.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.050± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (2.5%)</td>
<td>27.80 ± 0.90&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.62 ± 0.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.053± 0.04&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (5%)</td>
<td>32.40 ±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>19.27 ±0.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.060± 0.11&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (2.5%)</td>
<td>35.40±0.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.10 ±0.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.063± 0.15&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (5%)</td>
<td>39.40±0.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.20 ±0.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.066± 0.11&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD</td>
<td>1.072</td>
<td>1.16</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Each value is represented as mean ± standard deviation (n = 3).

Mean under the same column bearing different superscript letters are different significantly (p≤0.05).
Anti-obesity Effect of Flax Seed (*Linum usitatissimum*) and Avocado (*Persea Americana*) on Induced Obese Rats

Table (2): Effect of avocado, flax seed and their mixture on liver functions level of obese rats

<table>
<thead>
<tr>
<th>Treatment/Parameter</th>
<th>AST (U/L)</th>
<th>ALT (U/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (-)</td>
<td>110.50±1.70&lt;sup&gt;₁&lt;/sup&gt;</td>
<td>50.50±0.80&lt;sup&gt;₁&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control group (+)</td>
<td>252.50±1.85&lt;sup&gt;²&lt;/sup&gt;</td>
<td>83.50±1.40&lt;sup&gt;²&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (2.5%)</td>
<td>210.0±1.50&lt;sup&gt;₃&lt;/sup&gt;</td>
<td>70.50±1.20&lt;sup&gt;₃&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (5%)</td>
<td>184.0±1.30&lt;sup&gt;₃&lt;/sup&gt;</td>
<td>63.50±0.90&lt;sup&gt;₃&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (2.5%)</td>
<td>224.5±1.40&lt;sup&gt;₄&lt;/sup&gt;</td>
<td>76.50±0.80&lt;sup&gt;₄&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (5%)</td>
<td>195.50±1.10&lt;sup&gt;₅&lt;/sup&gt;</td>
<td>74.50±0.60&lt;sup&gt;₅&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (2.5%)</td>
<td>151.0±1.40&lt;sup&gt;₅&lt;/sup&gt;</td>
<td>63.50±0.40&lt;sup&gt;₅&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (5%)</td>
<td>131.0±1.10&lt;sup&gt;₆&lt;/sup&gt;</td>
<td>58.50±0.50&lt;sup&gt;₆&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD</td>
<td>5.16</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Each value is represented as mean ± standard deviation (n = 3).

Mean under the same column bearing different superscript letters are different significantly (p ≤ 0.05).

Table (3): Effect of avocado, flax seed and their mixture on serum total cholesterol and triglycerides of obese rats

<table>
<thead>
<tr>
<th>Treatment/Parameter</th>
<th>Total cholesterol (mg/dl)</th>
<th>Triglycerides (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (-)</td>
<td>95.50±1.16&lt;sup&gt;₁&lt;/sup&gt;</td>
<td>63.00±1.10&lt;sup&gt;₁&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control group (+)</td>
<td>135.50±1.17&lt;sup&gt;₁&lt;/sup&gt;</td>
<td>133.00±1.16&lt;sup&gt;₁&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (2.5%)</td>
<td>104.50±1.13&lt;sup&gt;₂&lt;/sup&gt;</td>
<td>97.50±1.15&lt;sup&gt;₂&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (5%)</td>
<td>98.50±1.14&lt;sup&gt;₃&lt;/sup&gt;</td>
<td>83.50±1.13&lt;sup&gt;₃&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (2.5%)</td>
<td>109.50±1.13&lt;sup&gt;₃&lt;/sup&gt;</td>
<td>101.00±1.15&lt;sup&gt;₃&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (5%)</td>
<td>100.00±1.15&lt;sup&gt;₄&lt;/sup&gt;</td>
<td>89.50±1.14&lt;sup&gt;₄&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (2.5%)</td>
<td>94.50±1.12&lt;sup&gt;₅&lt;/sup&gt;</td>
<td>71.50±1.11&lt;sup&gt;₅&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (5%)</td>
<td>87.50±1.11&lt;sup&gt;₆&lt;/sup&gt;</td>
<td>51.50±1.12&lt;sup&gt;₆&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD</td>
<td>2.65</td>
<td>2.38</td>
</tr>
</tbody>
</table>

Each value is represented as mean ± standard deviation (n = 3).

Mean under the same column bearing different superscript letters are different significantly (p ≤ 0.05).
Table (4): Effect of avocado, flax seed and their mixture on lipid profile of obese rats

<table>
<thead>
<tr>
<th>Treatment/Parameter</th>
<th>(HDL-C) (g/dl)</th>
<th>(LDL-C) (g/dl)</th>
<th>(VLDL-C) (g/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (-)</td>
<td>26.50±1.13</td>
<td>56.40±1.10</td>
<td>12.60±1.12</td>
</tr>
<tr>
<td>Control group (+)</td>
<td>45.00±1.15</td>
<td>63.90±1.16</td>
<td>26.60±1.15</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (2.5%)</td>
<td>28.00±1.10</td>
<td>57.00±1.14</td>
<td>19.50±1.13</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (5%)</td>
<td>34.30±1.13</td>
<td>47.50±1.14</td>
<td>16.70±1.12</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (2.5%)</td>
<td>30.00±1.13</td>
<td>59.30±1.15</td>
<td>20.20±1.10</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (5%)</td>
<td>33.00±1.11</td>
<td>49.10±1.13</td>
<td>17.90±1.13</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (2.5%)</td>
<td>37.50±1.14</td>
<td>42.70±1.15</td>
<td>14.30±1.11</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (5%)</td>
<td>39.10±1.14</td>
<td>38.10±1.12</td>
<td>10.30±1.15</td>
</tr>
</tbody>
</table>

LSD 2.96 3.60 2.76

HDL-C= High density lipoprotein cholesterol. LDL =Low density lipoprotein cholesterol. VLDL = Very low density lipoprotein cholesterol. Each value is represented as mean ± standard deviation (n = 3). Mean under the same column bearing different superscript letters are different significantly (p ≤ 0.05).

Table (5): Effect of avocado, flax seed and their mixture on uric acid, urea and creatinine of obese rats

<table>
<thead>
<tr>
<th>Treatment/Parameter</th>
<th>Creatinine (mg/dl)</th>
<th>Urea (mg/dl)</th>
<th>Uric acid (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (-)</td>
<td>1.80±1.10</td>
<td>25.40±1.12</td>
<td>1.80±1.15</td>
</tr>
<tr>
<td>Control group (+)</td>
<td>4.18±1.13</td>
<td>48.5±1.10</td>
<td>3.50±1.11</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (2.5%)</td>
<td>3.21±1.11</td>
<td>36.5±1.13</td>
<td>2.90±1.14</td>
</tr>
<tr>
<td>Obese rats with avocado fruits powder (5%)</td>
<td>3.06±1.10</td>
<td>30.50±1.11</td>
<td>2.60±1.10</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (2.5%)</td>
<td>3.49±1.12</td>
<td>39.10±1.10</td>
<td>2.85±1.14</td>
</tr>
<tr>
<td>Obese rats with flax seed powder (5%)</td>
<td>2.93±1.14</td>
<td>33.50±1.12</td>
<td>2.45±1.13</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (2.5%)</td>
<td>2.14±1.13</td>
<td>29.10±1.15</td>
<td>1.92±1.13</td>
</tr>
<tr>
<td>Obese rats with mixture of avocado fruits and flax seed powder (5%)</td>
<td>1.94±1.15</td>
<td>27.50±1.14</td>
<td>1.85±1.11</td>
</tr>
</tbody>
</table>

LSD 1.10 2.65 1.14

Each value is represented as mean ± standard deviation (n = 3). Mean under the same line bearing different superscript letters are different significantly (p ≤ 0.05).
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تناول الممض للسمنة: لبذور الأفوكادو وثمار الأفوكادو في الفئران المصابة بالسمنة
عماد محمد الخولي - طارق محمد عفيفي - أُميرة أحمد حمودة
قسم التغذية وعلوم الأطعمة - كلية الاقتصاد المنزلي - جامعة المنوفية

الملخص العربي
تم تقديم تأثير تركيزات مختلفة (0.2%, 0.5%) في صورة مسحوق من ثمار الأفوكادو وبذور الكتان وملوثهم
في الفئران المصابة بالسمنة. واستخدم 48 فأر في هذه الدراسة وتم تقسيمها إلى 6 مجموعات، كل مجموعة
تحتوي على 8 فئران. وتم إصاب الفئران بالسمنة بالتمريض على وجبة عالية الدهون (20% دهن حيواني)
بعرض السمنة. وأظهرت النتائج أن أعلى قيمة للزيادة في وزن الجسم، كمية الغذاء المتأول وكفاءة استخدام
الغذاء سجلت مع تركيز 0.5% من خليط من مسحوق ثمار الأفوكادو وبذور الكتان، في حين أن أقل قيمة سجلت
مع تركيز 0.2% مسحوق ثمار الأفوكادو مع وجود فرق معنوي. أعلى انخفاض إنزيمات الكبد ALT, AST
الدهون الثلاثية والكولسترول سجلت مع مجموعة الفئران التي تغذت على خليط من مسحوق ثمار الأفوكادو و
بذور الكتان بنسبة 0.5% مع وجود فرق معنوي. في حين أعلى قيمة للكولسترول عالي الكثافة وصلت مع
مجموعة الفئران التي تغذت على خليط من مسحوق الأفوكادو وبذور الكتان بنسبة 0.5%. بينما أقل قيمة من
الكولسترول منخفض الكثافة و الكولسترول منخفض الكثافة. جدا سجلت مع مجموعة الفئران التي تغذت
على خليط من مسحوق الأفوكادو وبذور الكتان بنسبة 0.5% أقل قيمة للإسترود وأحماض الدهون والكولستيرين
سجلت مع مجموعة الفئران التي تغذت على خليط من مسحوق الأفوكادو وبذور الكتان بنسبة 0.5% الخلاصة.
وجد أن مجموعة الفئران المصابة بالسمنة والتي تغذت على خليط من مسحوق الأفوكادو وبذور الكتان بنسبة
0.5% سجلت أفضل النتائج في تصميم صورة دهون الدم (الكولسترول عالي الكثافة) ووظائف الكبد بالمقارنة
بالفئران المصابة بالسمنة والتي تغذت على مسحوق ثمار الأفوكادو تركيز 0.2%.

الكلمات الأفتتاحية: ثمار الأفوكادو - بذور الكتان - الفئران - التأثير الممض للسمنة - التحاليل الكيميائية الحيوية.