Anti-obesity and Hypolipidemic Effects of Gymnema Sylvestre Leaves on Rats Fed on High Fat Diet

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المجلة البحوثية animation مجالات التربية النوعية

التأثيرات المضادة للسمنة والمخفضة لدهون الدم لأوراق الجيمينيا على الفئران

المغذاة على وجبة عالية الدهون

عبير نزيه عبد الرحمن، بسمة رمضان محمد خطيب

ملخص البحث

تهدف هذه الدراسة إلى دراسة تأثير الوجبة المرتفعة في الدهون والمعززة

بهستويات مختلفة من أوراق الجيمينيا على الفئران المصابة بالسمنة. تم استخدام ثلاثون من ذكور الفئران البيضاء والتي تزن 051 - 061 جم. تم تقسيمهم إلى خمس مجموعات. تناولت المجموعة الكنترول الوجبة الأساسية طوال فترة التجربة. بينما المجموعات المختبرة 24 فأرا قد تم تغذيتهم على الوجبة المرتفعة الدهون لمدة ثلاثة أسابيع. إنخفاض معياري في كل من المأخوذ الغذائي، الوزن المكتسب و معدل كفاءة الغذاء وذلك عند مستوى (0.05) فقط مقارنة بالمجموعة الضابطة الموجبة. بينما أظهرت المجموعة الضابطة الموجبة ارتفاعا معياريا في مؤشرات السمنة السابق ذكرها وذلك مقارنة بالمجموعة الضابطة السالبة. كما أظهرت النتائج أيضًا انخفاضا معياريا في مستوى كل من هرمون الليبتين، هرمون الغدة الدرقية، الكولسترول الكلي، الجليسيردات الثلاثية، الليبروتين المنخفض الكثافة، الليبروتين المنخفض جدا في الكثافة وعامل تصلب الشرايين وذلك مقارنة بالمجموعة الضابطة الموجبة. ومن جهة أخرى فقد أظهرت النتائج ارتفاعا معياريا في مستوى كل من ( الليبروتين المرتفع الكثافة، T3 و T4) مقارنة بالمجموعة الضابطة الموجبة. من خلال النتائج المتحصل عليها توصى الدراسة بضرورة إدراج أوراق الجيمينيا ضمن مشروباتنا أو أغذيتنا اليومية لما لها من فوائد عظيمة، هذا بالإضافة إلى ضرورة إجراء المزيد من الأبحاث التي تبرز الدور الفعال لهذه الأوراق في علاج العديد من الأمراض.

الكلمات المفتاحية: الجيمينيا، الوزن المكتسب، دهون الدم، هرمون الليبتين، هرمونات الغدة الدرقية، T3، T4، معامل تصلب الشرايين.
Anti-obesity and Hypolipidemic Effects of Gymnema Syylvestre Leaves on Rats Fed on High Fat Diet

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Abstract

This work aimed to study the effects of high fat diet enriched with Gymnema Syylvestre leaves (GSL) on obese rats. Thirty (30) male albino rats weighting 150-160g used in this study and assigned to 5 groups. The negative control group received basal diet throughout the experimental period. However, the experimental groups including 24 rats were feed on specific high fat diet (HFD) for 21 days to induced by obesity and hyperlipidemic rats. Rats fed on high fat diets treated with GSL at (2, 4 and 6%) indicated significantly decrease (p≤ 0.05) in feed intake (F.I), body weight gain (BWG), and feed efficiency ratio (FER) at (p≤ 0.05) comparing with control positive. In the same time the positive control group significantly increased in FI, BWG and FER compared to the negative control group. Also, tested leaves showed a significant decreases (p≤ 0.05) in mean value of leptin hormone, TSH, T.C, T.G, LDL, VLDL and AI comparing with control positive group. On the other hand there were a significant increases (p≤ 0.05) in means values of T3, T4 and HDL of obese rats treated with GSL. In conclusion, GSL could be recommended in our daily drinks and diets in a moderate amount (5-10 g).

Keywords: Gymnema Syylvestre, Body weight gain, Lipid profile, Leptin hormone, Thyroid hormones, T3, T4, Atherogenic Index.
Introduction

Obesity defined as a measurement of body mass index (BMI) which can calculated by dividing body weight (k.g) / (on) height (metres square), the proportion of overweight for adults from 25 to 29.9, obesity 30 or more. For children, BMI standards require modifications for age and sex. Obesity is a big problem. Obesity is related to a lot of illnesses such as hypercholesterolemia, hypertension, type 2 diabetes, gallstones, gastro esophageal, psychological changes and psychiatric morbidity (NICE, 2014).

Hypercholesterolemia means that blood cholesterol measurement more than 200 mg/dl. A cholesterol level between 200 to 239 mg/dl is considered boundary high, and more than 240 mg/dl considered a high cholesterol (Sergio and Juan, 2019). Hypercholesterolemia is a major danger factor for coronary blood vessels disease (Sridevi et al., 2004). It can cause the formation and accumulation of plaque deposits in the arteries. Appositive correlation has been found between more consumption of fiber and the reduction of coronary blood vessels diseases and diabetes happening (Abel et al., 2005). However, the intake of fiber is usually lower than recommended, thus, the expansion of high fiber food should be eligible. Cardiovascular diseases consider the main cause of death and illness in the advanced countries, became the superior health problem worldwide. Atherosclerosis is an a progressive disease described by the pilling up of cholesterol specially (LDL.c) with fibrous elements in the large arteries, would frame the most important volunteer to this growing load of cardiovascular disease (Parsaeet al., 2006 and Stapleton et al., 2010). Foods plans contain a huge amounts of bioactive compounds which provide eligible health support with essential nutrition. Epidemiological index recommended more consumption of vegetables and fruits for its positive modulation for human health. In the last decades, especial interest has been was for eaten plants; especially those rich in secondary metabolites (phytochemicals) (Maria et al., 2011). Foliage vegetables and fruits have produced interest worldwide as they offer a lot of benefits for health of carotenoids such as α-carotene, β-carotene - carotene and β - cryptoxanthin present in agricultural
produce have provitamin –A activity and are strong cancer, neurological antioxidants and modulate the pathogenesis of several inveterate diseases (Niziu and Rodering, 2005).

GS is a perennial woody vine that implant in tropical region of India, Africa, and Australia and has been used for medicinal intent in conventional medicines (Tiwari et al., 2014). Its common names including gymnema, Periploca of the woods, and gurmar, which means "sugar destroyer" (Ulbricht et al., 2011) and (Sanematsu et al., 2014). leaves and extracts containing the major bioactive constituents that interact with taste receptors (gymnemic acids) (Gardner and Mc-Guffin, 2013). GS has been used in herbal medications. It has a wide range of therapeutic properties. Its leaves contain gurmarin, flavonoids, triterpenoid and saponins. The most bioactive compound of this plant are gymnemic acids, a class of tri-terpenoid saponins, which have the effect of put down the taste of sweetness on the tongue from sucrose, xylitol, stevia and made up sweeteners such as aspartame (Liu et al., 2004 and Di-Fabio et al., 2015). In Japan, there were 50 tons of GSL are consumed every year for weight loss. Researches indicated that having a specified combination of G.S extract, hydroxyl citric acid, and niacin-bound chromium by mouth for eight weeks reduced body weight (Ogawa et al., 2004). G.S popularly known as gurmar for its special properties as sugar destroyer, it is a respectable herb in the ayurvedic system of medicine. The phytoconstituents responsible for sweet extinction activity are (triterpene, saponins) which known as gymnemic acids, gymnemasaponins, and a polypeptide, gurmarin. This herb helps a wide range of therapeutic effects as an effective natural therapy for diabetes, hypercholesterolemia, osteoporosis, arthritis, diuretic, anemia, constipation, indigestion, microbial infections and anti-inflammatory. GS has a perfect effects in the treatment of diabetes, it showed favorable effects on blood sugar homeostasis, control sugar cravings, and elevate renovation of pancreas. GS extract is used in dietary supplements for reducing body weight, blood cholesterol, and triglyceride levels (Pragvaet al., 2014). G.S conceder one of the indispensable medicinal plants which used as a medicine for the treatment of various diseases such as...
diabetes mellitus and obesity (Thakur et al., 2009; Thakuret al., 2009 and Sanodiyaet al., 2009).

This study was aimed to investigate the effects of treatment with GS by 2,4 and 6% in HFD-stimulate obesity and related metabolic defects in Albino rats.

Materials and methods

Plant materials: GS was purchased from Harraz market in Cairo then gristed to a powder and kept in dark stoppard glass bottle in the refrigerator at 4 °C till use.

Rats and diets: Male albino rats, weighing 150-160g per each were purchased from Medical Insects Research Institute, Dokki, Cairo, Egypt. Basal diet constituents were gained from El-Ghomhorya for Chemicals and Drug Trading, Cairo, Egypt.

Chemicals: Kits for analysis were bought from Gama Trade Company for chemicals, Cairo, Egypt. The basal diet set according to the following formula as mentioned by Campbell,(1963) as follow: 10% protein, 10% corn oil, 1% vitamin mixture, 4% mineral mixture, 0.2% choline chloride, 0.3% methionine, 5% cellulose, and then completed with corn starch (about 69.5%). Vitamin mixture was recommended by Hegested et al.,(1941), while the salt mixture was according to Drury and Wallington, (1980). High fat diet was prepared by adding 20% cheap fat to the basal diet.

Experimental Design:

Thirty male Albino rats were housed in healthy condition (21-23°C), with 40-60% humidity and fed on the basal diet. Water and diet were introduced ad labium for seven days for acclimatization. After acclimatization, rats were divided into two main groups, the first group (6 rats) still fed on basal diet and the other main group (24 rats) was fed on high fat diet for 21 days to induce obesity and hyperlipiemia, then this group classified into the following sub groups:

• (2): Fed on HFD only as a control positive.
• (3): Fed on HFD + 2% GSL
• (4): Fed on HFD + 4% GSL
• (5): Fed on HFD + 6% GSL
At the end of the experimental (4 weeks), animals were fasted for 12-h then were scarified. Samples of blood were taken from the portal vein into clean and dry centrifuge tubes for separation the serum, blood samples centrifuged for 10 minutes at 3000 rpm to separate the serum according to Drury and Wallington, (1980). Serum samples were frozen at –20 °C until chemical analysis.

Feed intake (FI) was calculated every day, body weight gain (BWG) and feed efficiency ratio (FER) was calculated at the end of the experimental period.

**Lipid Profile and Atherogeric Index Assay**

Total Cholesterol was determined according to Allain et al.,(1974), Triglycerides (T.G) according to Fassati and Prencipe, (1982), High Density Lipoprotein (H.D.L-c) according to Lopez, (1977), Low Density Lipoprotein (L.D.L-c) and Very Low Density lipoprotein (V.L.D.L-c) were calculated by following equation:

- \[ \text{LDL-Cholesterol} = \text{Total cholesterol} - \{\text{HDL-c} + \text{TG}/5\} \]
- \[ \text{VLDL-c} = (\text{TG}/5) \]


Leptin Hormone, Thyroxin (T4) and Tri-iodothyronine (T3) assay:

Leptin hormone was determined using ELISA (Enzyme-Linked Immunosorbsent Assay) according Xiong et al., (2005).

T4 and T3 were determined according to Sapin and Schlienger, (2003).

**Statistical Analysis:**

The obtained data were written as mean ± standard deviation (S.D) by ANOVA test at (P≤0.05) according to SAS , (2006).

**Results and Discussion**

**Effect of GSL on feed intake g/day/rat, body weight gain (BWG %) and Feed Efficiency Ratio (FER) of obese rats**

Data in Table (1) indicated that rats fed on high fat diet had increased the mean value of FI (20.16 ± 2.02 g/d/rat) compared to control negative group (13.5 ± 1.50) g/d/rat. Obese rats treated with GSL (2.4 and 6%) showed lower values in FI compared with the control positive group. The values were 18.53 ± 1.429, 16.83 ± 1.650 and 14.26±0.971g/d/rat, respectively. With regard to BWG% result revealed that the positive control group had observed increases in BWG% comparing with control negative. Also, rats...
which treated with the levels of GSL (2,4 and 6%) showed decreases in mean values of BWG% and FI comparing with control positive group. The best results of FI, BWG% and FER were records for group 5 (obese rats treated with 6% GSL).

**Table (1) : Effect of GSL on feed intake (g/day/rat), body weight gain (BWG %) and Feed Efficiency Ratio (FER) of obese rats**

<table>
<thead>
<tr>
<th>Groups</th>
<th>FI (g/day/rat)</th>
<th>% of change</th>
<th>B.W.G (%)</th>
<th>% of change</th>
<th>FER</th>
<th>% of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Control (-)</td>
<td>13.5 ± 1.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-33.04</td>
<td>10.59 ± 2.38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-27.22</td>
<td>1.22 ± 0.281&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-22.29</td>
</tr>
<tr>
<td>(2) Control (+)</td>
<td>20.16 ± 2.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>---</td>
<td>14.55 ± 0.865&lt;sup&gt;a&lt;/sup&gt;</td>
<td>---</td>
<td>1.57 ± 0.199&lt;sup&gt;a&lt;/sup&gt;</td>
<td>---</td>
</tr>
<tr>
<td>(3) GSL 2%</td>
<td>18.53 ± 1.429&lt;sup&gt;a&lt;/sup&gt;</td>
<td>- 8.09</td>
<td>-9.94 ± 1.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-163.32</td>
<td>-1.19 ± 0.217&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-175.79</td>
</tr>
<tr>
<td>(4) GSL 4%</td>
<td>16.83 ± 1.650&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>- 16.52</td>
<td>-12.65 ± 0.989&lt;sup&gt;d&lt;/sup&gt;</td>
<td>- 186.94</td>
<td>-1.66 ± 0.103&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-205.73</td>
</tr>
<tr>
<td>(5) GSL 6%</td>
<td>14.26 ± 0.971&lt;sup&gt;b&lt;/sup&gt;</td>
<td>- 29.27</td>
<td>-18.62 ± 0.334&lt;sup&gt;c&lt;/sup&gt;</td>
<td>- 227.97</td>
<td>-2.91 ± 0.20&lt;sup&gt;d&lt;/sup&gt;</td>
<td>-285.35</td>
</tr>
<tr>
<td>L.S.D</td>
<td>2.823</td>
<td>---</td>
<td>2.40</td>
<td>---</td>
<td>0.379</td>
<td>---</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different (p≤ 0.05)

Treatment with *G. sylvestre* extract (GSE) by (200 mg/kg) showed significantly (P ≤ 0.01) decreased in the B.M.I comparing with HFD treated groups (Nakamura et al., 1999). This perhaps due to the reduction in feed intake that lead to decrease the intake of calorie. Extract of G.S are rich in more active compounds such as phytochemicals, gymnemic acids and gurmarin (Khramov et al., 2008). Gurmarin is recognized to block the ability of sweet taste and bitter flavors, so, it reduces longing for foods (Ninomiya and Imoto, 1995). Gurmarin acts on supported greater petrosal nerve of palatal taste buds by decreases the phasic response to sugars (Harada and Kasahara, 2000).

These results (Table 1) in the same line with Preusset et al., (2004) who showed that GS acts to elevate weight loss for its ability to reducing cravings for desert and control blood sugar levels. Also, it has been reported that GS extract combination with niacin-bound chromium and hydroxycitric acid so, it has been promoting for anti obesity activity by observation changes in BW, BMI, appetite and serum leptin. GSE can use as an effective, easily and safe weight loss formula for reduction body weight and BMI also enhanced healthy blood lipid profiles.
Shivaprasad et al., (2006) indicated that the hexane extract of GS leaves has anti-obesity activity.

Also, Kim et al., (2016) reported that the methanolic extracts of GS is anti-obesity effects in HFD by decreasing body weight gain and feed efficiency ratio.

**Effect of GSL on leptin hormone of obese rats**

Data tabulated in Table (2) reflected the influence of GSL on leptin hormone for obese rats. Data showed that treated groups showed significant \((P \leq 0.01)\) decrease in leptin hormone, as compared to the control positive group, on the other hand, leptin hormone decreased gradually with increasing the level of GSL.

**Table (2) : Effect of GSL on leptin hormone of obese rats**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>L.S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (-)</td>
<td>Control (+)</td>
</tr>
<tr>
<td>Leptin Hormone (ng/ml)</td>
<td>52.13 ± 2.437e</td>
<td>94.53 ± 1.625a</td>
</tr>
<tr>
<td>% of Change</td>
<td>-44.85</td>
<td>----</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same row sharing the same superscript letters are not statistically significantly different \((p \leq 0.05)\)

Leptin hormone levels positively renovated with body fat on a HFD (Fried et al., 2000). Leptin able to participate to hepatic steatosis by elevating insulin opposition and modified insulin signaling in hepatocytes, so, it is promote increased intracellular lipids (Uygun et al., 2000). Therefore, GSE inhibit the increase of leptin by decreasing the body fat content of rats fed on HFD.

This result is in the same line with Lavie and Milani, (2003) they reported that serum leptin level in the HFD supplemented with GSE group were significantly decreased compared with HFD group. Also, Vinay et al., (2012) reported that treatment with ethanolic GSE by 200 m/kg/body for 28 days revealed a significant decreases in leptin in the obese wistar rats. Kumaret et al., (2013) reported that water soluble fraction of GS ethanolic extract (GSEE) significantly reduced serum leptin. Also, this finding is in agreement with the findings of Kim et al., (2016) they reported that the methanol extracts of G.S has a significant anti-obesity effects in group fed on HFD supplemented with GS by the decreasing of leptin compared with the HFD group.

**Effect of GSL on T3, T4 and TSH hormones of obese rats**
The effect of GSL on T3, T4 and TSH hormone of obese rats were tabulated in Table (3). For T3 hormone, it could be observed that the highest mean value was in the group (5) which fed on 6% GSL compared to control (+) group. There is no significant differences between group (5) and control (-) group. Group (5) recorded as the best treatment. For T4 hormone, it could be noticed that the highest mean value was in the group "5" which fed on high fat diet containing 6% GSL while the lowest mean value was in the control (+) group which fed on basal diet which was 1.023±0.106 (ng/ml). There were significant differences between all groups. The best effect was detected in the group fed on high fat diet containing 6% GSL compared with control (-) group. Concerning TSH, it could be observed that there is no differences between group (3) and control positive group. Group (5) recorded the best treatment compared to control (-) group.

Table (3):- Effect of GSL on T3, T4 and TSH hormones of obese rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>T3 (ng/ml)</th>
<th>% of Change</th>
<th>T4 (ng/ml)</th>
<th>% of Change</th>
<th>TSH (µg/dl)</th>
<th>% of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Control (-)</td>
<td>82.68 ± 2.659a</td>
<td>42.55</td>
<td>3.8 ±0.264a</td>
<td>271.46</td>
<td>0.146 ±0.025c</td>
<td>-91.13</td>
</tr>
<tr>
<td>(2) control (+)</td>
<td>58 ±2.645d</td>
<td>----</td>
<td>1.023 ±0.106e</td>
<td>----</td>
<td>1.646 ±0.066a</td>
<td>----</td>
</tr>
<tr>
<td>(3) GSL 2%</td>
<td>62.46 ±2.51c</td>
<td>7.69</td>
<td>1.7 ±0.435d</td>
<td>66.17</td>
<td>1.466 ±0.208a</td>
<td>-10.94</td>
</tr>
<tr>
<td>(4) GSL 4%</td>
<td>73 ± 2.098b</td>
<td>25.86</td>
<td>2.4 ± 0.4c</td>
<td>134.60</td>
<td>1.033 ±0.152b</td>
<td>-37.24</td>
</tr>
<tr>
<td>(5) GSL 6%</td>
<td>78.33 ± 2.08a</td>
<td>35.05</td>
<td>3.2 ±0.264b</td>
<td>212.81</td>
<td>0.386±0.146c</td>
<td>-76.55</td>
</tr>
<tr>
<td>LSD</td>
<td>4.388</td>
<td>----</td>
<td>0.576</td>
<td>----</td>
<td>0.248</td>
<td>----</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different (p≤ 0.05).

Effects of GSL on Total Cholesterol (T.C) and Triglycerides (T.G) of obese rats

Findings presented in Table (4) illustrate the effects of GSL on lipid profile for obese rats. It could be noticed for T.G, that the highest mean value was in the control (+) group which fed on basal diet and the lowest mean was in the group fed on 6% GSL compared to control (+) group. There were significant differences between all groups. For T.C, it could be showed that the highest mean value in the control (+) group which fed on basal diet and the lowest mean was in the group fed on 6% GSL...
compared to control (+) group. There is no significant between groups (5) and control (-) group. Group (5) recorded as the best treatment.

Table (4): Effect of GSL on Total Cholesterol (T.C) and Triglycerides (T.G) of obese rats

<table>
<thead>
<tr>
<th>Group</th>
<th>T.G (mg/dl)</th>
<th>% of Change</th>
<th>T.C (mg/dl)</th>
<th>% of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) control</td>
<td>46.63 ± 2.318&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-64.22</td>
<td>59.3 ± 2.051&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-33.79</td>
</tr>
<tr>
<td>(2) control</td>
<td>130.33± 1.069&lt;sup&gt;a&lt;/sup&gt;</td>
<td>----</td>
<td>89.56± 3.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>----</td>
</tr>
<tr>
<td>(3) GSL 2%</td>
<td>101.9± 3.404&lt;sup&gt;b&lt;/sup&gt;</td>
<td>- 21.81</td>
<td>82.93± 2.433&lt;sup&gt;b&lt;/sup&gt;</td>
<td>- 7.40</td>
</tr>
<tr>
<td>(4) GSL 4%</td>
<td>79 ± 2.455&lt;sup&gt;c&lt;/sup&gt;</td>
<td>- 39.38</td>
<td>73.73± 2.458&lt;sup&gt;c&lt;/sup&gt;</td>
<td>- 17.68</td>
</tr>
<tr>
<td>(5) GSL 6%</td>
<td>62.90± 2.487&lt;sup&gt;d&lt;/sup&gt;</td>
<td>- 51.74</td>
<td>60.96 ± 1.94&lt;sup&gt;d&lt;/sup&gt;</td>
<td>- 31.93</td>
</tr>
<tr>
<td>L.S.D</td>
<td>4.480</td>
<td>----</td>
<td>4.446</td>
<td>----</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different (p≤ 0.05).

Gymnemagenin from the extracts of GS leaf of raises the fecal secretion of cholesterol, bile acids and neutral steroids (Persaud et al., 1999). Hexane extract of the leaves of GS had anti obesity activity. It has been found that, administration of hexane extract of G. sylvestre for 45 days improved the total cholesterol, triglyceride, LDL, and HDL levels. The extract of G.S have a potential effect to treat obesity similar with the standard drug (atorvastatin). The researches demonstrated that leaf extract has a good probability in the reduction of cholesterol levels and considered as a herbal medication for treating obesity (Shivaprasadet al., 2006). Also, administration of leaf extracts of GS to hyperlipidemic rats for two weeks founded to reducing serum total cholesterol and (T.C) triglyceride (T.G) so, it had a hypolipidemic activity (Rachhet al., 2010). Treatment with integrated ethanolic GSE by 200 m/kg/body for 28 days showed a significant decreases in serum T.C and T.G in obese wistar rats (Vinayet al., 2012). Kumar et al., (2013) reported that water soluble fraction of ethanolic extract of GS significantly reduced serum lipid profile, while it significantly increased the HDL-cholesterol. Kim et al.,(2016) showed that the methanol extracts of GS decrease serum levels of T.C and triglyceride T.G in HFD. The reduction of abdominal as well as adipocyte hypertrophy and epididymal fat weight.

Effect of G.S.L on high density lipoprotein cholesterol (HDL.c), low density lipoprotein cholesterol (LDL.c)
and very low density lipoprotein cholesterol (VLDL.c) of obese rats

Data in Table (5) showed the mean values of HDL, LDL and VLDL of obese rats treated with GSL by different levels. For HDL, it could be noticed that the highest mean value was in the group fed on 6% GSL and the lowest mean was in control (+) group which fed on basal diet. There is no significant differences between groups (5) and control (-) group. Also, for LDL, It could be noticed that the highest mean value was in control (+) group which fed on basal diet which was 50.6±1.398 (mg/dl) and the lowest mean was in the group fed on 6% GSL which was 19.98 ±3.973 (mg/dl) compared to control (+) group. There were a significant differences between all groups except group 3 and group (2). In case of VLDL, the highest mean value was in control positive group which fed on standard diet which was 26. 06± 0.213 mg/dl and the lowest mean was in the group fed on 6% GSL which was12.58 ± 0.497(mg/dl). There were significant differences between all groups.

Table (5): Effect of G.S.L on high density lipoprotein cholesterol (HDL.c), low density lipoprotein cholesterol (LDL.c) and very low density lipoprotein cholesterol (VLDL.c) of obese rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>HDL.c mg/dl</th>
<th>% of change</th>
<th>LDL.c mg/dl</th>
<th>% of change</th>
<th>VLDL.c mg/dl</th>
<th>% of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Control (-)</td>
<td>30.13 ± 2.30a</td>
<td>133.57</td>
<td>19.84± 3.412c</td>
<td>- 60.79</td>
<td>9.33 ± 0.463c</td>
<td>- 64.21</td>
</tr>
<tr>
<td>(2) control (+)</td>
<td>12.9 ± 2.21c</td>
<td>----</td>
<td>50.6± 1.398a</td>
<td>----</td>
<td>26.07 ± 0.213a</td>
<td>----</td>
</tr>
<tr>
<td>(3) GSL 2%</td>
<td>16.5± 1.83b</td>
<td>27.91</td>
<td>46.05± 4.206a</td>
<td>- 8.99</td>
<td>20.38 ± 0.680b</td>
<td>- 21.83</td>
</tr>
<tr>
<td>(4) GSL 4%</td>
<td>18.96± 1.68b</td>
<td>46.98</td>
<td>38.96± 2.778b</td>
<td>- 23.00</td>
<td>15.8± 0.490c</td>
<td>- 39.39</td>
</tr>
<tr>
<td>(5) GSL 6%</td>
<td>28.40± 1.90a</td>
<td>20.16</td>
<td>19.98± 3.977c</td>
<td>- 60.51</td>
<td>12.58 ± 0.497d</td>
<td>- 51.75</td>
</tr>
<tr>
<td>LSD</td>
<td>3.640</td>
<td>----</td>
<td>6.024</td>
<td>----</td>
<td>0.896</td>
<td>----</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different (p≤ 0.05).

These results are supported by the results published by Lavie and Milani, (2003) they demonstrated that obesity had adversely affects on plasma lipids by increasing T.C, T.G, LDL-C, VLDL-C, and decreasing HDL-C. Levels of T.C, T.G, LDL-C, VLDL-C, and atherogenic index (A.I) were significantly decreased in HFD supplemented with GSE. Hyson et al., (2002)
noticed that LDL-C and its oxidation are related to cardiovascular diseases. Treatment with standardized ethanolic G.S.E by 200 m/kg for 28 days showed a significant decreases in serum LDH and LDL-C, whereas, serum HDL-C, levels were significantly increased in obese wistar rats (Vinayet al., 2012).

The results agreed with the ones reported by Rachhet al., (2010) who reported that feeding rats on GS leaves extract (GSLE) increased HDL.c level and decrease T.C, T.G, LDL.c and VLDL.c levels. Also, Aziza et al., (2013) indicated that treatment of streptozotocin induced diabetic rats with GSLE significantly reduced blood T.C, LDL-c levels and increased HDL-c levels.

G.S at doses of (100mg/kg) and (200mg/kg) significantly reduced lipid profile (T.C,T.G,VLDL and LDL) levels while, (HDL) was increased significantly. The dose of 200 mg/kg GS was found more effective than dose of 100 mg/kg G.S. (Dheeraj et al., 2017).

Effect of GSL on Atherogeric index (AI) of obese rats

Data of Table (6) revealed the effect of GSL on Atherogeric index for obese rats. Data showed that all treated groups showed significant decrease in AI, when compared with the control positive group, on contrast, AI decreased gradually by increasing the level of GSL.

Table (6):- Effect of GSL on Atherogeric index (AI) of obese rats

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>L.S.D</th>
<th>1.002</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Control (-)</td>
<td>(2) Control (+)</td>
<td>(3) GSL2%</td>
</tr>
<tr>
<td>AI (ratio)</td>
<td>0.976± 0.190d</td>
<td>6.04± 0.905a</td>
<td>4.076± 0.690b</td>
</tr>
<tr>
<td>% Change</td>
<td>-84.17</td>
<td>----</td>
<td>-32.52</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Values in the same row sharing the same superscript letters are not statistically significantly different (p≤ 0.05)

Conclusion: the tested leaves GSL in this study was efficient of decreasing body weight gain, leptin hormone and lipid profile. These findings confirming our supposition that tested leaves had several important compounds which are able to treated obesity and hyperlipidemia. Therefore, we recommended these leaves by a modest amount (about 5 g daily) to be in our daily diets or drinks.
References


