**Original paper**

**Effects of Tea Seed Oil on Hyperlipidemic Rats Induced by High-fat Diet**

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To explore the hypolipidemic and hepatoprotective effects of tea seed oil, we administered tea seed oil and olive oil to rats to construct the rat hyperlipidemic model induced by high-fat diet, determined biochemical parameters in blood with biochemical kits and biochemical analyzer, calculated arteriosclerosis index (AI) and liver coefficient (LC), detected pathological changes of the livers by microscope and analyzed statistically significant difference of the parameters among the groups. Results showed that tea seed oil can significantly inhibit the body weight gain of rats induced by the high fat diet, significantly decrease concentration levels of triglyceride, total cholesterol, low density lipoprotein cholesterol and activities of aspartate transaminase, alanine transaminase in serum as well as the values of arteriosclerosis index (AI) and liver coefficient (LC) of the hyperlipidemic rats, significantly increase concentration levels of high density lipoprotein Cholesterol of the hyperlipidemic rats, significantly diminish the accumulation of lipid droplets in liver and abate liver damages of hyperlipidemic rats. Conclusion is that tea seed oil has good hypolipidemic and hepatoprotective effects on hyperlipidemic rats.

Keywords: tea seed oil, hypolipidemic effect, hepatoprotective effect, mechanism, hyperlipidemic rat.

**Introduction**

Studies showed that the increase of levels of total cholesterol (TC), total triglycerides (TG) or low-density lipoprotein-cholesterol (LDL-c) or the decrease of high-density lipoprotein-cholesterol as (HDL-c) level in serum can result in hyperlipidemic diseases, fatty liver, myocardial infarction, especially atherosclerosis (Wen et al. 2006; Chen et al. 2012; Devi and Shama 2004). Hyperlipidemia is an important risk factor related to the initiation of cardiovascular diseases and fatty liver (Hu et al. 2010; Lei et al. 2011; Teng et al. 2011). Fatty liver especially non-alcoholic fatty liver disease (NAFLD) is closely associated with visceral obesity, dyslipidemia and is an independent risk factor for cardiovascular disease (Lee et al. 2010; Byrne 2010; Pacana and Fuchs 2012). The specific hypolipidemic and hepatoprotective properties of daily food materiel which contain rich bioactive ingredients are particularly vital for preventing cardiovascular diseases (Krawczyk et al. 2010; Assaoui et al. 2011; Belghith et al. 2012; Chandrashekar et al. 2010). Thus, research on hypolipidemic effect of foods has gotten more and more attention from the society (Chanya and Amorn 2011).

Tea seed oil is commonly used as cooking oil in China, and used as an adjuvant in medicine. It is similar to olive oil in fatty acid composition and is known as the “Oriental olive oil” (Huang and Wu 2010). It contains rich oleic acid, linolic acid, saponin, vitamin E, carotene, phospholipids, squalene, sesamin, polyphenols, 2, 5-bis-benzo[1,3]dioxol-5-yl-tetrahydro-furo [3,4-d] [1,3] dioxine (Bo et al. 2008; Liao et al. 2005; Lee, et al. 2007). Additionally, we detected 47 kinds of chemical compositions (including 19 aldehydes, 8 alcohols, 5 ketones, 4 alkanes, 3 acids, 2 esters, 2 alkenes and 5 other substances) from tea seed oil with HS-GC-MS (Headspace gas chromatography mass spectrometry) method. According to the facts that tea seed can use its main chemical components –lipids (content up to 40%) to develop and form a robust seedling, tea seed oil may contain the active ingredients that are able to convert lipids into other substances of life. So tea seed oil has antioxidant effects, and can lower blood...
pressure, reducing blood fat, slow the progression of atherosclerosis, prevent cardiovascular disease (Wang et al. 2006; Lee et al. 2007). The methanol extracts of tea seed oil (METSO) can reduce the formation of intercellular reactive oxygen species (ROS), inhibit LDL oxidation, protect lymphocytes against H_2O_2 induced genetic injury in vitro, and a tea seed oil diet can protect the liver from oxidative damage induced by CCl_4 in rats (Lee et al. 2007). Olive oil is the principal source of fat in Mediterranean diets which have shown functional effects against several degenerative pathologies, including cardiovascular diseases and cancer (Oi-Kano et al. 2007; Urpi-Sarda et al. 2012). It has been described to be an antioxidant and exhibits activities of anticarcinogenic, anti-inflammatory. Hypolipidemic and hepatoprotective effects of tea seed oil on hyperlipidemic rats induced by high-fat diet has not been reported yet. In the present study, the rat hyperlipemia model was constructed using a high-fat diet to investigate the potential hypolipidemic and hepatoprotective effects of tea seed oil on hyperlipidemia rats. The results showed that tea seed oil has good hypolipidemic and hepatoprotective effects in hyperlipidemia rats.

**Materials and Methods**

**Preparation of tea seed oil**  The tea seeds were harvested in the oil tea trees (Camellia oleifera Able.) experimental base of Changsha University of Science and Technology (in October). The tea seed oil was extracted using supercritical fluid extraction (Huang and Wu 2010; Lucue et al. 2002).

**Table 1.** ingredients of the basic diet and high-fat diet

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Basic diet</th>
<th>Content (% wt/wt)</th>
<th>High-fat diet</th>
<th>Content (% wt/wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour</td>
<td>20</td>
<td>Basic diet</td>
<td>80</td>
<td>12.5</td>
</tr>
<tr>
<td>Rice flour</td>
<td>10</td>
<td>lard</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Corn</td>
<td>20</td>
<td>yolk powder</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Bran</td>
<td>25</td>
<td>cholesterol</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Pulse flour</td>
<td>20</td>
<td>sodium cholate acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone meal</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish meal</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Number of rats, weight of diets and weight of complements (g/kg.BW/d) in each day and the calorie level of six groups (Kcal/kg/d).

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of rats</th>
<th>Diet</th>
<th>Weight</th>
<th>Complement</th>
<th>Weight</th>
<th>the calorie level</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFD</td>
<td>10</td>
<td>High-fat diet</td>
<td>150</td>
<td>water</td>
<td>9</td>
<td>572</td>
</tr>
<tr>
<td>NCG</td>
<td>10</td>
<td>basic diet</td>
<td>150</td>
<td>water</td>
<td>9</td>
<td>402</td>
</tr>
<tr>
<td>TOH</td>
<td>10</td>
<td>High-fat diet</td>
<td>150</td>
<td>Tea seed oil</td>
<td>9</td>
<td>653</td>
</tr>
<tr>
<td>TOM</td>
<td>10</td>
<td>High-fat diet</td>
<td>150</td>
<td>Tea seed oil</td>
<td>3</td>
<td>599</td>
</tr>
<tr>
<td>TOL</td>
<td>10</td>
<td>High-fat diet</td>
<td>150</td>
<td>Tea seed oil</td>
<td>1.5</td>
<td>585</td>
</tr>
<tr>
<td>OOG</td>
<td>10</td>
<td>High-fat diet</td>
<td>150</td>
<td>olive oil</td>
<td>9</td>
<td>653</td>
</tr>
</tbody>
</table>

HFD: high-fat diet group; NCG: normal control group; OOG: olive oil group; TOH: Tea seed oil high dosage group; TOM: Tea seed oil medium dosage group; TOL: Tea seed oil low dosage group.

The table 2 showed that the calorie levels of rats in 6 groups are NCG<HFD<TOL<TOM <TOH=OOG.

**Composition of diet**  Composition of the basic diet (Tianqing Biological Technology, Changsha, China) and high-fat diet was showed in table 1.

**Experimental design**  Male Sprague–Dawley (SD) rats (150 ± 10 g) that were used for the experiments were purchased from Tianqin Laboratory Animal Center (Changsha, PR China). The rats were housed in a room with a regulated temperature (25 ± 2°C) and relative humidity (55 ± 2%), with a 12:12 h light-dark circle. They were allowed free access to food and water. At first, all the rats were fed with a normal diet to adapt to the feeding condition for 7 days. Then, the rats were randomly divided into six groups (ten rats/group). Weight of diets, weight of complements (tea seed oil, olive oil or water) and calorie level for rats in six groups were showed in table 2.

The diets were fed to rats in each group each day according to standards and requirements in table 2. The oil or water (the dosage for each rat in each group was determined according to the provisions in table 2) were administered to the rats by oral gavage once daily for 7 weeks. At the initiation of the experiments and at the end of every other week, BWs were measured. Throughout the experiments, food consumption was recorded at the end of every week, and the average food consumption per animal was calculated at weekly intervals. At the end of the seventh week, the animals were anesthetized with aether following fasting for 12 h; and their blood (2 – 3 mL) was taken from their hearts for biochemical analysis. The animals were then euthanized; the liver was removed from each cadaver for pathological analysis and liver coefficients (LC) analysis.
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Assay of Serum biochemical parameters  Blood was placed at room temperature for 1 hour and centrifuged at 3000 r/min for 10 min to obtain serum. Serum was stored at 20°C until it was used in biochemical assays. Triglyceride (TG), total cholesterol (TC), high density lipoprotein Cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) were determined using TG kit, TC kit, HDL-c kit and LDL-c kit (Beijing wantai DRD CO., LTD., Beijing, PR China), respectively. The atherosclerosis index (AI) was calculated according to AI = (TC-HDL-c)/HDL-c. To identify whether tea seed oil has the hepatoprotective effect on liver, Aspartate transaminase (AST) and Alanine transaminase (ALT) activities in all the blood serum samples were determined using NSA-300 fully automated biochemistry analyzer (Shenyang Neusoft Medical Systems, Shenyang, China).

Histopathologic studies of liver  After the livers were weighed, the liver coefficients (LC) were calculated according to the formula: LC(%) = liver weight/body weight × 100. The liver tissues was treated with conventional methods and made into slices. The slices were stained with hematoxylin and eosin (H&E) (Woo et al. 2009). The changes of liver pathology was scored as described by Ni and Chen (2010), as follows: 0 = no visible fatty vacuole; 1 = fatty vacuole > 5% of tissue; 2 = fatty vacuole > 10% of the tissue; 3 = fatty vacuole > 25% of the tissue; 4 = fatty vacuole > 50% of the tissue. The morphology of any lesions observed was classified and recorded. A double blind method was used in the pathological examination of the livers.

Statistical analysis  All data were expressed as mean ± SD. Statistical analysis was completed with SPSS 16.0 (SPSS, Inc., Chicago, IL, USA). The statistical analysis was performed using One-way ANOVA followed by LSD or L-N-K test to explore the differences between groups. P < 0.05 was considered to be significant.

Results  

Effects of tea seed oil on food consumption values and body weight gain for the rats  Effects of tea seed oil on food consumption values for rats were presented in Fig.1. The results showed that there is no significant difference among the average intake for rats in different groups, because their food intake daily was determined according to their body weight. Calorie intake for each rat daily in 6 groups is shown in Fig. 2. The results showed that calorie intake for rats in TOH, TOM, TOL, OOG and HFD group was very significantly higher than that of rats in the NCG group (P < 0.01); calorie intake for rats in TOH and OOG groups was significantly higher than that of rats in the HFD group (P < 0.05).

Effects of tea seed oil on body weight (BW) gain for rats are presented in Fig.3. Fig. 3A showed that rate of the BW gain of rats decreased with the increase of time; the BW gains of the rats in the three dose groups of tea seed oil decreased with the increase of the dose of oil. Fig. 3B showed that the BW gain of rats in TOH and TOM was very significantly or significantly lower than that of rats in the HFD (p < 0.01 or p < 0.05), except TOL. There was no significant difference among BW gain of rat in TOH, TOM and OOG. These findings suggested that tea seed oil has the effect of inhibiting the BW gain of rats induced by the high fat diet. Its effective dosage is 3 g/kg.BW/d.

Effect of tea seed oil on serum lipid levels of the rats  TG,TC, HDL-c, LDL-c were determined using the kits. The results were presented in Table 3. The results showed content of TG, TC and LDL-c in serum of rats in HFD group was very significantly higher than those of rats in NCG (p < 0.01); content of HDL-c in serum of rats in HFD group was very significantly lower than those of rats in NCG (p < 0.01). This indicated that the high fat diet induced hyperlipidemia in rats. Content of TG and TC in the serum of rats in TOH, TOM, TOL and OOG did not significantly differ from those of rats in NCG. Content of HDL-c in the serum of rats in TOH and OOG did not significantly differ from those of rats in NCG, with those of rats in TOM and TOL were significantly lower than those of rats in NCG. LDL-c level of rats in all streated groups were significantly higher than those of rats in NCG. TC and LDL-c in the serum of rats in TOH, TOM, TOL and OOG were significantly or very significantly lower than those of rats in the HFD, with HDL-c content in serum of rats in TOH and OOG were significantly (p < 0.05) or very significantly (p < 0.01) higher that of rats in HFD, except that HDL-c content in serum of rats in TOL did not significantly differ from those of rats in HFD (p > 0.05). Three grams/kg.BW/d dose of tea seed oil have hypolipidemic effect on hyperlipidemic rats induced by the high fat diet.

Effect of tea seed oil on atherosclerosis index  The atherosclerosis index (AI) of rats in each group were calculated by the formula. Results were presented in Table 4. AI values of rats in HFD was very significantly higher than those of rats in NCG, with AI values of rats in TOH, TOM and OOG did not significantly differ from those of rats in NCG except those of rats in TOL. AI values of rats in TOH, TOM, TOL and OOG were very significantly lower than those of rats in the HFD. Nine grams or three grams/kg.BW/d of tea seed oil can decrease significantly the AI values of hyperlipidemic rats (P < 0.05).

Effect of tea seed oil on activities of ALT and AST in serum of the rats  Effects of tea seed oil on activities ALT and AST in serum of the rats were showed in Fig. 4. Fig. 4A showed activities of ALT in serum of rats in HFD were very significantly higher than those of rats in NCG (p < 0.01), up to 1.47 times. ALT activities of rats in TOH, TOM, TOL, OOG and NCG were significantly (p < 0.05) or very significantly (p < 0.01) lower than those of rats in HFD. There are no significant differences among ALT activities in serum of rats in TOH, TOM, TOL, OOG and NCG. Fig. 4B showed AST activities in serum of rats in HFD were significantly higher than those of rats in NCG, up to 1.49 times. The AST activities of rats in TOH were significantly lower than those of rats
in HFD. There are no significant differences among AST activities in serum of rats in TOH, TOM, TOL, OOG and NCG. Results suggested that tea seed oil have hepatoprotective effect on hyperlipidemic rats induced by high lipid diet.

There was no significant difference among activity of ALT and AST in serum of rats in TOH, TOM, TOL, OOG and those of rats in NCG.

Effects of tea seed oil on Liver coefficients (LC) of the rats
Effects of tea seed oil on LC of the rats in each group were showed in table 5. There was no significant difference among the LC of rats in TOH, TOM, TOL, OOG and NCG. The LCs of rats in TOH, TOM, TOL, OOG and NCG were significantly lower than those of rats in HFD (P < 0.05 or P < 0.01).

Protective effects of tea seed oil on liver tissue
Morphological changes of liver tissue of the experimental rats were detected using histopathological microscopy. Results were shown in Fig. 5. Number of the lipid droplets (Fig. 5C, Fig. 5D, Fig. 5E, Fig. 5F) in liver of rats in OOG, TOH, TOM and TOL group was remarkably less than those of rats in HFD (Fig. 5B). Grades of the histological injury were evaluated according to morphological changes of liver hepatocytes and the number of lipid droplets in liver. Results were presented in Table 6. Livers of rats in HFD had 6 rats with III injury and 1 rat with IV injury. Livers of rats in TOH, TOM and OOG did not have III and IV injury. Results suggested that tea seed oil could diminish the accumulation of lipid droplets in liver of hyperlipidemic rats induced by high fat diet and have hypolipidemic and hepatoprotective effect on hyperlipidemic rats.

Discussion
The present study was designed to investigate the hypolipidemic and hepatoprotective effects of tea seed oil on hyperlipidemic rats model. As expected, high-fat diet that is rich in cholesterol and saturated fats can induce dyslipidemia (Lei et al. 2011). When tea seed oil was orally administrated to those...
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Hyperlipidemic rats, it could significantly reduce the level of TG, TC and LDL-c, and remarkably raise the level of HDL-c \( P < 0.05 \). The results proved that the hypolipidemic activity of tea seed oil was as effective as that of olive oil. This indicates that tea seed oil could be developed as a functional food for preventing hyperlipidemia. The effect of tea seed oil that reduced level of TG, TC and LDL-c and increased level of HDL-c in serum of hyperlipidemic rats mostly attributed to the high content of

![Graph of BW gain comparison](image1)

![Graph of total BW gain comparison](image2)

**Fig. 3.** Comparing change of BW gain and differences in weight gain of rats in 6 groups. (A): Comparing change of BW gain of rats in 6 groups. (B): Comparing differences in BW gain of rats in 6 groups. \( n=10, \ g/rat \).

* denotes comparison between all the other groups and NCG group. **: \( p < 0.01 \), *: \( p < 0.05 \).

# denotes comparison between TOH, TOM, TOL, OOG group and HFD group, ##: \( p < 0.01 \), #: \( p < 0.05 \).

**Table 3.** Comparing blood lipid levels of rats in 6 groups (mmol/L)

<table>
<thead>
<tr>
<th>Group</th>
<th>NCG</th>
<th>HFD</th>
<th>TOH</th>
<th>TOM</th>
<th>TOL</th>
<th>OOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>1.02±0.31</td>
<td>2.73±0.37 **</td>
<td>1.12±0.43 #</td>
<td>1.43±0.19 #</td>
<td>1.61±0.75 #</td>
<td>1.08±0.31 ##</td>
</tr>
<tr>
<td>TC</td>
<td>2.09±0.35</td>
<td>2.85±0.55 **</td>
<td>2.01±0.28 #</td>
<td>1.89±0.36 #</td>
<td>2.25±0.46 #</td>
<td>1.93±0.27 ##</td>
</tr>
<tr>
<td>HDL-c</td>
<td>1.77±0.23</td>
<td>1.36±0.14 **</td>
<td>1.67±0.18 #</td>
<td>1.49±0.34 **,#</td>
<td>1.25±0.25 **</td>
<td>1.75±0.32 ##</td>
</tr>
<tr>
<td>LDL-c</td>
<td>0.39±0.04</td>
<td>0.92±0.10 **</td>
<td>0.76±0.07 *,#</td>
<td>0.79±0.08 *,#</td>
<td>0.70±0.06 *,#</td>
<td>0.78±0.08 *,#</td>
</tr>
</tbody>
</table>

* denotes comparison between all the other groups and NCG group. **: \( p < 0.01 \), *: \( p < 0.05 \).

# denotes comparison between TOH, TOM, TOL, OOG group and HFD group, ##: \( p < 0.01 \), #: \( p < 0.05 \).
unsaturated fatty acids in tea seed oil. Unsaturated fatty acids, especially polyunsaturated fatty acids (PUFA) have been widely recognized to lower serum lipid and assist in suppressing the risk of atherosclerosis (Shireen et al. 2008). In fact, tea seed oil is comprised of 75 – 80% oleic acid and 8 – 10% linoleic acid. Besides, tea seed oil also contains some minor active components such as saponin, polyphenols, vitamin E, carotene, phospholipids, squalene, sesamin, tocochromers, phytosterol, and squalene and so on, which have been reported to inhibit cholesterol deposition in the arteries and maintain stability of the lipoprotein structure by their antioxidant activity. Since free radicals are the source of lipid peroxidation and contribute to the hypercholesterolemic

<table>
<thead>
<tr>
<th>Group</th>
<th>NCG</th>
<th>HFD</th>
<th>TOH</th>
<th>TOM</th>
<th>TOL</th>
<th>OOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>0.18</td>
<td>1.1</td>
<td>0.5</td>
<td>0.49</td>
<td>0.84</td>
<td>0.39</td>
</tr>
<tr>
<td>±0.004</td>
<td>±0.035**</td>
<td>±0.031##</td>
<td>±0.029##</td>
<td>±0.03*,#</td>
<td>±0.034##</td>
<td></td>
</tr>
</tbody>
</table>

* denotes comparison between all the other groups and NCG group, **: p < 0.01, *: p < 0.05.
# denotes comparison between TOH, TOM, TOL, OOG group and HFD group, ##: p < 0.01, #: p < 0.05.

Fig. 4. Comparing activity of ALT and AST in serum of rats in 6 groups.
(A): Comparing ALT activity in serum of rats in 6 groups.
(B): Comparing AST activity in serum of rats in 6 groups.
* denotes comparison between all the other groups and HFD group, **: P < 0.01, *: P < 0.05.
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In previous study, it was also proposed that some bioactive components may work on lowering the TG level by activation of the lipoprotein lipase (LPL) leading to the generation of free fatty acids or inhibition of lipogenic enzymes (Ju et al. 2008). Squalene, phytosterol and polyphenols existed in tea seed oil may be responsible for the hypolipidemic effect. Tea seed oil probably played a role in hindering the intestinal cholesterol absorption or restraining the activities of the key enzymes such as hepatic acyl-CoA oxidase, fatty acid synthase and hydroxyl-3-methylglutaryl-coenzyme A reductase (HMG-CoA) in endogenous cholesterol biosynthesis (Woo et al. 2009; Kwak et al. 2010).

AI is regarded as an important measurable index for atherosclerosis. The results indicated that tea seed oil decreased the AI level due to increased HDL-c and decreased LDL-c. There was no significant difference among AI of rats in TOH and TOM. We can infer that 3 g/BW.kg/d of tea seed oil is sufficient to prevent atherosclerosis.

This study indicated tea seed oil significantly diminished the accumulation of fat droplets in liver. The measurement of activities of AST and ALT in serum can directly suggest whether the level of hepatic damage especially fatty liver induced by high cholesterol is serious or not (Garcia-Mediavilla et al. 2003). AST activity in serum of rats in TOH and ALT activity of rats in three groups treated by tea seed oil were significantly lower in than those of rats in HFD.

According to the fact that tea seeds can use its major chemical components-lipids (content up to 40%) to develop and form robust seedling, we consider that tea seed oil may contain active components that are able to convert lipids into other matters of life. These active ingredients can reduce the content of lipids in the serum, and then protect the liver, prevent hepatic damage and reduce activities of ALT and AST in serum by means of converting lipids into other matters of life. They may play a more important role in the hepolipidemic and hepatoprotective effects of tea seed oil.

<table>
<thead>
<tr>
<th>Table 5.</th>
<th>the comparison of liver coefficient of rats in 6 groups (n=10, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>NCG</td>
</tr>
<tr>
<td>LC</td>
<td>2.53</td>
</tr>
<tr>
<td>±0.37 #</td>
<td>±0.34</td>
</tr>
</tbody>
</table>

# denotes comparison between TOH, TOM, TOL, OOG, NCG group and HFD group, # #: p < 0.01, #: p < 0.05.

<table>
<thead>
<tr>
<th>Table 6.</th>
<th>Histological injury score of liver of rats in 6 groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>number</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>NCG</td>
<td>10</td>
</tr>
<tr>
<td>HFD</td>
<td>9</td>
</tr>
<tr>
<td>TOH</td>
<td>10</td>
</tr>
<tr>
<td>TOM</td>
<td>9</td>
</tr>
<tr>
<td>TOL</td>
<td>10</td>
</tr>
<tr>
<td>OOG</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 5. Representative micrographs of liver tissue of rats from 6 groups (×240).
A: NCG; B: HFD; C: OCG; D: TOH; E: TOM; F: TOL;
The large bright spots are fat droplets; the blue points are hepatocytes.
In conclusion, the present results demonstrated that tea seed oil, which is rich in unsaturated fatty acids and bioactive constituents, has the potential effects to prevent the hepatic diseases induced by high fatty diets. The findings suggested tea seed oil can be developed as a functional oil for preventing and treating hyperlipidemia and fatty liver in the future. However, further studies should be carried out to deeply elucidate the mechanisms of the hepatoprotective and hepatoprotective effects of tea seed oil in vivo.

Conclusions

The findings in the present study suggested that tea seed oil can significantly inhibit the body weight gain of rats induced by the high fat food, significantly decrease content of TG, TC and LDL-c in serum as well as activities of ALT and AST, the AI values, the liver coefficients of the hyperlipidemic rats, significantly increase content of HDL-c; significantly diminish the accumulation of lipid droplets in liver and abate liver damages of hyperlipidemic rats. Tea seed oil has the hypolipidemic and hepatoprotective effect on hyperlipidemic rats.

Acknowledgments

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Compliance with ethical standards

Conflict of interest

There was no conflict of interest from the authors related to this paper.

Compliance with ethics requirements

This experiment was approved by the Institutional Animal Care and Use Committee (IACUC) of the Changsha, China.

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