Anti-Hypertensive Effects of Blended *Camellia oleifera* Abel Oil and Eucommia Extract on SHR Mice

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**Abstract**

In our study, we employed Camellia seed oil as the main ingredients blended with Eucommia Extract to investigate the effects of anti-hypertensive on mice by administrating mice with low dose, middle dose and high dose of Camellia seed oil complex for 4 weeks. The specific tests of studying effects of anti-hypertensive were body weight, blood systolic pressure (BSP), diastolic blood pressure (DBP), mean blood pressure (MBP) and heart rate (HR). And the results showed that appropriate level of Camellia seed oil complex could decrease the body weight and had an active effect on the cardiovascular system of mice, which significantly embodied the anti-hypertensive activity of Camellia seed oil complex.

**Keywords**

Camellia Seed Oil, Eucommia Extract, Anti-Hypertensive, Mice

1. **Introduction**

Camellia (*Camellia oleifera* Abel.) seed oil is unique woody oil in China which is widely used in south of China as edible oil, medicine and burning injury for thousands of years. It has high nutritional value and has been considered a popular healthy food because it mainly composed of unsaturated fatty acids and a small amount of saturated fatty acids. Furthermore, it contains a considerable numbers of bioactive phytochemicals such as phytosterols, squalenes and tocopherol. Its fatty acid composition is similar to olive oil, which known as the "queen of vegetable oil" (Xia, 2015). The content of unsaturated fatty acid is over 90%, oleic acid is up to 80% (Zhu et al., 2012; Dong, 2011; Chen, 2011) and some nutrients are even higher than olive oil (Zhong et al., 2006). The Camellia
seed oil is applied as functional food and food supplementary to help patients reduce contents of cholesterol and triglycerides in blood (Lee & Yen, 2006; Fedeli et al., 1966). Zhang and Zhou et al. reported that tea oil had antioxidant ability against several degenerative pathologies, including cardiovascular diseases and cancer (Zhang & Zhou, 1995). Moreover, the Camellia seed oil was shown to have an anti-obesity effect in vivo model. However, little information has been devoted to the anti-fatigue effects of the tea seed oil.

The extract of eucommia ulmoides had higher chlorogenic acid (Zang, 1989) and chlorogenic acid has a variety of pharmacological effects such as cholagogic, antibacterial, antiviral, anti-hypertensive, raising white blood cells and stimulating the central nervous system (Zhang et al., 2001). So it is an important raw material for health care, food, medicine, cosmetics and other industries.

Our goal is to evaluate the effect of anti-hypertensive activity of the complex of Camellia seed oil blended Eucommia extract in mice. And we will evaluate the possibility of Camellia seed oil blended Eucommia extract as human daily food in next studying.

2. Materials and Methods

2.1. Materials

Tea seed oil from Camellia oleifera Abel was obtained by cold-press technique from Jiande Xiawu Agriculture Development Co., Ltd., Zhejiang, China.

Eucommia Extracts were purchased from Qingdao New Research Nonferrous Metal Co., Ltd., Qingdao, China.

Tea seed oil complex: adding the tea seed oil and Eucommia Extract, with the ratio of (100:1), at 30˚C - 70˚C in a flask, the mixture was stirred fiercely with T25 digital ultra-turrax high-speed homogenizer, IKA Co., Germany, till the tea seed oil and Eucommia Extract distributed well and keep at 4˚C in refrigerator.

Solvent: Sucrose fatty acid esters were purchased from Mitsubishi Corporation of Japan. Adding 2% sucrose fatty acid esters in 1000 ml distilled water (98˚C), the mixture was stirred fiercely with T25 digital ultraturrax high-speed homogenizer, IKA Co., Germany, till the mixture was distributed well and cooled down.

2.2. Animals

SHR mice (SPF Grade, male, 10 weeks old) and Wistar mice (SPF Grade, male, 10 weeks old) were purchased from Shanghai slack laboratory animal Co. Ltd. (SCXK (Hu) 2007-0005). All animal procedures performed were in accordance with the standard Guidelines for Animal Studies and approved by the Institutional Animal Ethics Committee.

2.3. Methods

After being fed for 20 days, 50 male SHR mice were divided into 4 groups randomly according to their basic blood pressure and body weights. one group named model control group (MCG) was supplemented with 10 ml·kg⁻¹ solvent
day\(^{-1}\) by oral intake in the food, the other three group named low dose group (LDG), middle dose group (MDG) and high dose group (HDG) were administrated 0.5, 1.0 and 2.0 g·kg\(^{-1}\)·day\(^{-1}\) of tea seed oil complex by oral intake respectively. 10 male Wistar mice as normal control group (NCG) was administrated 10 ml·kg\(^{-1}\) solvent day\(^{-1}\) by oral intake. Mice were performed the weight test, blood pressure measurement and heart rate test at the 0 week, 1\(^{st}\) week, 2\(^{nd}\) week, 3\(^{rd}\) weeks and 4\(^{th}\) weeks.

2.4. Condition

Mice were housed in SPF Laboratory maintained at 22°C ± 1°C, 50% - 70% humidity and 150 - 200 Lx intensity of light with a 12 h light/dark cycle. 60 mice were randomly divided into polycarbonate cages. 5 mice in each set allowed free access to eat and drink water. The water was filtered and sterilized. And the feed was radioactive by Co 60 to sterilize.

2.5. Instrument

ALC-NIBP Noninvasive blood pressure measurement system of rat tail artery, Shanghai Alcott biotechnology Co., Ltd.

MLS-3020 High pressure sterilizer, Sanyo electronics Co., Ltd. of Japan.

AG204 Alectronic analytical balance METTLER Co., Ltd. of Swiss land.

2.6. Data Statistics

Data were analyzed using SPSS 11.5 version (SPSS Inc., Chicago, IL, USA). The results were demonstrated as the mean ± S. The significance of the mean difference between the control groups and each treatment group was performed by one-way AVOVA test.

3. Result

3.1. Different Treatment Groups Body Weight

Comparing with NCG, MCG the initial body weight was significantly higher than that of NCG (\(P < 0.01\)), however, after feeding 3 weeks, MCG the body weight was significantly lower than that of NCG (\(P < 0.05\)). LDG, MDG and HDG comparing with MCG, there was no significant change in body weight (\(P > 0.05\)) after feeding 4 weeks (Table 1).

| Group | Doseage        | Initial Weight | 1 Week   | 2 Week   | 3 Week   | 4 Week   |
|-------|----------------|----------------|----------|----------|----------|----------|
| NCG   | 10 ml·kg\(^{-1}\) solvent | 311.0 ± 11.5   | 346.4 ± 12.6 | 358.5 ± 18.3 | 374.3 ± 20.0 | 375.9 ± 20.5   |
| MCG   | 10 ml·kg\(^{-1}\) solvent | 337.9 ± 20.0\(^{\Delta\Delta}\) | 352.2 ± 20.3 | 354.3 ± 20.1 | 352.4 ± 21.3\(^{\Delta}\) | 354.8 ± 23.0\(^{\Delta}\) |
| LDG   | 0.5 g·kg\(^{-1}\) oil | 344.5 ± 15.3   | 359.7 ± 15.3 | 363.9 ± 14.4 | 365.7 ± 16.8 | 366.7 ± 17.8   |
| MDG   | 1.0 g·kg\(^{-1}\) oil | 331.7 ± 18.6   | 341.6 ± 18.8 | 345.0 ± 17.2 | 350.3 ± 17.2 | 350.0 ± 18.7   |
| HDG   | 2.0 g·kg\(^{-1}\) oil | 339.3 ± 27.2   | 351.5 ± 25.5 | 358.4 ± 24.1 | 362.2 ± 18.8 | 359.0 ± 16.8   |

Significantly different from the normal control group, \(^{\Delta}\)\(P < 0.05\), \(^{\Delta\Delta}\)\(P < 0.01\); Significantly different from the model control group, \(^{*}\)\(P < 0.05\), \(^{**}\)\(P < 0.01\).
3.2. Effects of Tea Seed Oil Complex on BSP of Mice

Comparing with NCG, the blood systolic pressure (BSP) of MDG was significantly higher than that of NCG in 4 weeks test \((P < 0.01)\). Comparing with MCG, the BSP of HDG decreased significantly after feeding 2, 3 and 4 weeks \((P < 0.05, P < 0.01)\), the BSP of MDG decreased significantly after feeding 2 and 4 weeks \((P < 0.05, P < 0.01)\), the BSP of LDG decreased significantly after feeding 2 weeks \((P < 0.05)\) (Table 2).

3.3. Effects of Tea Seed Oil Complex on DBP of Mice

Comparing with NCG, the diastolic blood pressure (DBP) of MDG was significantly higher than that of NCG in 4 weeks test \((P < 0.01)\). Comparing with MCG, the DBP of HDG decreased significantly after feeding 2, 3 and 4 weeks \((P < 0.05, P < 0.01)\), the DBP of MDG decreased significantly after feeding 2 and 4 weeks \((P < 0.05, P < 0.01)\), the DBP of LDG decreased significantly after feeding 2 weeks \((P < 0.05)\) (Table 3).

3.4. Effects of Tea Seed Oil Complex on MBP of Mice

Comparing with NCG, the mean blood pressure (MBP) of MDG was significantly higher than that of NCG in 4 weeks test \((P < 0.01)\). Comparing with MCG, the MBP of HDG decreased significantly after feeding 2, 3 and 4 weeks \((P < 0.05, P < 0.01)\), the MBP of MDG decreased significantly after feeding 2 and 4 weeks \((P < 0.05, P < 0.01)\), the MBP of LDG decreased significantly after feeding 2 weeks \((P < 0.05)\) (Table 4).

### Table 2. Effects of tea seed oil complex on BSP of mice (mmHg, \(n = 10\), X ± s).

| Group | Doseage | Initial BSP | 1 Week | 2 Week | 3 Week | 4 Week |
|-------|---------|-------------|--------|--------|--------|--------|
| NCG   | 10 ml·kg⁻¹ solvent | 136.6 ± 18.2 | 134.3 ± 22.2 | 133.5 ± 22.5 | 144.5 ± 8.8 | 145.4 ± 10.3 |
| MCG   | 10 ml·kg⁻¹ solvent | 192.5 ± 10.5ΔΔ | 183.1 ± 8.5ΔΔ | 209.8 ± 2.4ΔΔ | 204.0 ± 6.8ΔΔ | 216.3 ± 5.1ΔΔ |
| LDG   | 0.5 g·kg⁻¹ oil | 192.0 ± 10.4 | 181.3 ± 19.8 | 197.0 ± 15.2* | 199.9 ± 14.2 | 207.8 ± 10.7 |
| MDG   | 1.0 g·kg⁻¹ oil | 191.0 ± 12.5 | 182.3 ± 17.0 | 191.2 ± 12.1** | 202.6 ± 11.4 | 205.0 ± 12.2* |
| HDG   | 2.0 g·kg⁻¹ oil | 192.8 ± 15.2 | 173.0 ± 23.7 | 186.2 ± 12.1** | 195.9 ± 7.0* | 190.9 ± 18.3** |

Significantly different from the normal control group, Δ\(P < 0.05\), ΔΔ\(P < 0.01\); Significantly different from the model control group, *\(P < 0.05\), **\(P < 0.01\).

### Table 3. Effects of tea seed oil complex on DBP of mice (mmHg, \(n = 10\), X ± s).

| Group | Doseage | Initial DBP | 1 Week | 2 Week | 3 Week | 4 Week |
|-------|---------|-------------|--------|--------|--------|--------|
| NCG   | 10 ml·kg⁻¹ solvent | 102.8 ± 15.0 | 101.6 ± 19.5 | 101.9 ± 17.4 | 109.3 ± 7.2 | 107.6 ± 7.7 |
| MCG   | 10 ml·kg⁻¹ solvent | 143.4 ± 9.4ΔΔ | 138.2 ± 9.8ΔΔ | 156.1 ± 5.5ΔΔ | 154.3 ± 7.3ΔΔ | 158.6 ± 7.5ΔΔ |
| LDG   | 0.5 g·kg⁻¹ oil | 143.0 ± 10.4 | 136.5 ± 10.7 | 147.2 ± 10.4* | 149.8 ± 9.6 | 153.0 ± 5.9 |
| MDG   | 1.0 g·kg⁻¹ oil | 143.0 ± 11.3 | 136.1 ± 12.8 | 140.6 ± 7.7** | 147.4 ± 9.0 | 149.5 ± 8.9* |
| HDG   | 2.0 g·kg⁻¹ oil | 142.4 ± 13.8 | 128.4 ± 15.7 | 139.9 ± 13.0** | 144.7 ± 5.6* | 140.3 ± 12.1** |

Significantly different from the normal control group, Δ\(P < 0.05\), ΔΔ\(P < 0.01\); Significantly different from the model control group, *\(P < 0.05\), **\(P < 0.01\).
3.5. Effects of Tea Seed Oil Complex on HR of Mice

Comparing with NCG, the heart rate (HR) of MDG was significantly higher than that of NCG in 4 weeks test \( (P < 0.05, P < 0.01) \). However, comparing with MCG, there was no significant change in HR \( (P > 0.05) \) between LDG, MDG and HDG to MCG after feeding 4 weeks (Table 5).

4. Discussion and Conclusion

The initial body weight of MCG was heavier than that of NCG, however, the body weight of MCG was lighter than that of NCG after 3 weeks feeding (Table 1). It suggested that Camellia seed oil blended Eucommia extract has the function of control body weight. In fact, obesity can lead to serious health issues, like cardiovascular disease (Wang et al., 2014). Furthermore, the complex of Camellia seed oil blended Eucommia extract can decrease BSP, DBP, MBP and HR (Tables 2-5). Our results demonstrated that the complex of Camellia seed oil blended Eucommia extract did good things to the cardiovascular system of SHRmice. The reason is that Camellia seed oil contained a great deal of unsaturated fatty acid (Oleic acid > 80%, \( \omega 9 \)) and micronutrient (phytosterols, squalenes and tocopherol) (Zhong et al., 2006). Oleic Acid Protects from Arsenic-Induced Cardiac Hypertrophy via AMPK/FoxO/NFATc3 Pathway (Samanta et al., 2019).

In conclusion, our results suggest that Camellia seed oil complex had significant anti-hypertensive effects on mice and these effects were dose-dependent. When dosage was high, it normally would improve the effects much better.

### Table 4. Effects of tea seed oil complex on MBP of mice (mmHg, \( n = 10 \), \( \overline{X} \pm s \)).

| Group | Doseage         | Initial MBP  | 1 Week  | 2 Week  | 3 Week  | 4 Week  |
|-------|-----------------|--------------|---------|---------|---------|---------|
| NCG   | 10 ml∙kg\(^{-1}\) solvent | 114.0 ± 15.8 | 112.5 ± 20.3 | 112.4 ± 19.0 | 121.0 ± 7.4 | 120.2 ± 8.3 |
| MCG   | 10 ml∙kg\(^{-1}\) solvent | 159.8 ± 9.4\(^{\Delta}\Delta\) | 153.2 ± 9.1\(^{\Delta}\Delta\) | 174.0 ± 4.3\(^{\Delta}\Delta\) | 170.8 ± 6.9\(^{\Delta}\Delta\) | 177.8 ± 6.3\(^{\Delta}\Delta\) |
| LDG   | 0.5 g∙kg\(^{-1}\) oil | 159.3 ± 10.0 | 151.5 ± 13.5 | 163.8 ± 11.8\(^{\ast}\) | 166.5 ± 10.9 | 171.3 ± 6.8 |
| MDG   | 1.0 g∙kg\(^{-1}\) oil | 159.0 ± 11.2 | 151.5 ± 13.3 | 157.5 ± 8.8\(^{\ast\ast\ast}\) | 165.8 ± 9.6 | 167.6 ± 9.4\(^{\ast}\) |
| HDG   | 2.0 g∙kg\(^{-1}\) oil | 159.2 ± 13.7 | 143.3 ± 18.2 | 155.3 ± 12.3\(^{\ast\ast\ast}\) | 161.8 ± 5.8\(^{\ast}\) | 157.1 ± 13.7\(^{\ast\ast\ast}\) |

Significantly different from the normal control group, \( ^{\Delta}P < 0.05, ^{\Delta\Delta}P < 0.01 \); Significantly different from the model control group, \( ^{\ast}P < 0.05, ^{\ast\ast}P < 0.01 \).

### Table 5. Effects of tea seed oil complex on HR of mice (bpm, \( n = 10 \), \( \overline{X} \pm s \)).

| Group | Doseage         | Initial HR  | 1 Week  | 2 Week  | 3 Week  | 4 Week  |
|-------|-----------------|--------------|---------|---------|---------|---------|
| NCG   | 10 ml∙kg\(^{-1}\) solvent | 379.0 ± 39.7 | 371.3 ± 52.0 | 355.8 ± 40.5 | 343.4 ± 23.5 | 332.5 ± 21.7 |
| MCG   | 10 ml∙kg\(^{-1}\) solvent | 420.7 ± 29.1\(^{\Delta}\) | 411.3 ± 46.9\(^{\Delta\Delta}\) | 417.6 ± 26.3\(^{\Delta\Delta}\) | 422.7 ± 27.2\(^{\Delta\Delta}\) | 413.2 ± 30.8\(^{\Delta\Delta}\) |
| LDG   | 0.5 g∙kg\(^{-1}\) oil | 425.6 ± 49.8 | 422.0 ± 37.2 | 429.3 ± 39.8 | 424.6 ± 31.6 | 437.5 ± 31.9 |
| MDG   | 1.0 g∙kg\(^{-1}\) oil | 405.9 ± 34.0 | 431.9 ± 20.9 | 414.0 ± 35.3 | 443.9 ± 27.2 | 417.8 ± 42.7 |
| HDG   | 2.0 g∙kg\(^{-1}\) oil | 439.0 ± 37.4 | 445.8 ± 36.2 | 428.5 ± 35.4 | 443.4 ± 21.3 | 419.9 ± 40.5 |

Significantly different from the normal control group, \( ^{\Delta}P < 0.05, ^{\Delta\Delta}P < 0.01 \); Significantly different from the model control group, \( ^{\ast}P < 0.05, ^{\ast\ast}P < 0.01 \).

DOI: 10.4236/ojf.2020.101001
Acknowledgements

This work was supported by the project of Science and Technology Department of Zhejiang Province, China (2017C02003).

Conflicts of Interest

The authors declare that they have no competing interests.

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