

# Antiobesity Effects of *Platycodon grandiflorum* Extract on Body Weight Changes and Serum Lipid Profiles of Obese Rats Induced High Fat Diet

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## Abstract

The present study was carried out to investigate the antiobesity effects of *Platycodon grandiflorum* extract on body weight changes and serum lipid composition of rats fed high fat diet. The *Platycodon grandiflorum* has been widely used as a folk food in the Orient for many centuries. We had experiment with *Platycodon grandiflorum* extract in order to find cure effects for obesity. The changes of the body weights in *Platycodon grandiflorum* extract treatment group showed a decrease in comparison with control group. Weekly body weights of PG group are respectively  $243.7 \pm 2.0$ g,  $283.5 \pm 4.3$  g,  $310.5 \pm 6.5$  g,  $333.2 \pm 7.5$  g,  $361.0 \pm 10.4$  g,  $390.5 \pm 11.5$  g,  $436.0 \pm 11.8$  g,  $454.4 \pm 11.4$  g,  $484.4 \pm 10.1$  g. Body weight of PG groups are decreased compared with those of control group, but the rates are not significant. Total cholesterol of PG group ( $77.2 \pm 3.3$  mg/dl) is decreased by 7.0% compared with that of control group. Serum triglyceride of PG group ( $103.6 \pm 9.0$ mg/dl) is decreased by 21.1% compared with that of control group. Serum free fatty acid of PG group ( $630.1 \pm 45.9$   $\mu$ Eq/l) is decreased by 19.6% compared with that of control group. Total lipid amount of PG group ( $393.6 \pm 23.7$  mg/dl) is decreased by 9.1% compared with that of control group. The above results suggest that *Platycodon grandiflorum* extract could prevent or cure metabolic diseases by preventing hyperlipemia caused by high fat diet.

**Key words** – Body weight-regulation, Obesity, *Platycodon grandiflorum*, Serum, Lipid

## Introduction

Obesity is defined as an abnormal state that lipid tissues in body are excessively increased. In a word, obesity does not merely mean overweighted state, it also means excessive accumulation of lipid in body by metabolic disorder[1].

The cause of obesity is that because intake of calorie exceeds the energy needed for the body function and the growth[2], triglyceride as a form of lipid is stored in lipid tissue too much. In other words, it is the im-

balance between the amount of calorie and energy[3].

For the present time being, the obese are showing a tendency to increase gradually due to the enhancement of standards of living and its effect, the change of diet habit[4].

The obesity rate of Korean children is lower than that of the Western, However, their surplus plasma lipid density has become something that we cannot disregard any more.

Not only abnormal lipid metabolism but also hypertension and diabetes are foreseeing the adult diseases in children is on the increase. That is to say, the obesity of children is becoming the serious social problem[5].

In addition, the obesity like this is withering indi-

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viduals socially and mentally at the same time. It sometimes induces uneasiness and dejection. It can be a disease in itself, and can be a major factor that increases the risk of adult disease such as high cholesterol, fatty liver, abnormal liver function, stenocardia, cardiac infarction, arteriosclerosis, coronary heart disease, stroke, hypertension, diabetes, hyperinsulinemia, decreased growth hormone secretion, *Pickwick* syndrome, and gout[6-8].

Besides, the mechanical and physical stress of the obesity is often the origin of various diseases and it induces these diseases; Osteoarthritis, lumbago, thrombosis, abdomen hernia, cholelithiasis[7].

In addition, the mortal rate of the obese is much higher than that of the normal. When it is supposed that the mortal rate of the normal is 100, that of the 10% obese is 120. In the case of 20%, 30%, and 40%. it is 125, 145 and 170 or so respectively. In other words, we can have the conclusion that the mortal rate gets higher in accordance with the higher obesity[9].

Actually, the statistics in U.S said that the death rate of the under-standard weight is lower by 20% compared to the average and that of the obese is higher by 20~40% compared to the average[10].

These days, the ingredients of staple foods are becoming proteins or lipids of high quality caused by the economic development. As a consequence of it, the obesity like this has appeared as a disease to be studied significantly in both Oriental and Western medical fields.

Hereby, we had experiment with *Platycodon grandiflorum* (PG) extract in order to find cure effects for obesity. I investigated the effects of *Platycodon grandiflorum* extract on body weight changes and serum lipid composition of obese rats fed high fat diet.

## Materials and method

### Materials

#### 1) Experimental Extracts Preparation

The extract of *Platycodon grandiflorum* extract, made of

500 g herb medicines was added to 2500 ml water and decocted for 4 hours. The extract of decoction liquid was condensed by evaporator. The condensed liquid was frozen by deep freezer for 12 hours. The frozen extracts were dried by lyophilization apparatus (Model 104, ALPHA, W, German) for 36 hours. The final amount of the extracts were 34 g.

#### 2) Animals and diets

Male Sprague-Dawley rats were purchased from Korean Experimental Animals(DJ 1617, Korean) and acclimated in a  $53 \pm 3\%$  humidity-controlled room maintained at  $22 \pm 2^\circ\text{C}$  with a 12-h light dark cycle. Before the experiment, rats were allowed free access to commercial chow diet(Samyang, Korean) for two weeks. Then rats were selected  $240 \pm 5\text{g}$  body weights. The rats of normal group were allowed free access to commercial chow diet and water for 8 weeks.

The rats of control group were fed high fat diet (Harlan, TD94095, USA) for 8 weeks. The rats of experimental group were fed high fat diet(Harlan, TD94095, USA) with each *Platycodon grandiflorum* (PG) extract (PG: 5.26 mg/100g b.w) for 8 weeks. The composition of high fat diet is shown as follows: Casein 260 g, DL-Methionine 3.9 g, Sucrose 161.7g, Corn Starch 160.0 g, Beef Tallow 300.0 g, Cellulose 50.0 g, Mineral Mix, AIN-76 45.5 g, Calcium Carbonate 3.9g, Vitamin Mix, Teklad 13.0 g, Choline dihydrpgen citrate 2.0 g.

### Analytical Method

#### 1) Blood collection and serum separation

The rats were sacrificed to determine their chemical composition. Blood was collected immediately after decapitation and serum was centrifuged in 3500 rpm for 10 min.

#### 2) Measurement of lipid profiles

Serum total cholesterol contents, triglyceride, free fatty acid, total lipid contents, phospholipid, HDL-cholesterol, LDL-cholesterol were measured by enzymatic colorimetry

CHOD-PAP method using Hitachi 747(Japan)[11].

3) Stastical analysis

The results were analyzed by student't-test, and p<0.05 was considered statistically significant.

Results

Body Weight

Change on the body weight of rats fed high fat diet. Weekly body weights of PG group are respectively 243.7 ±2.0g, 283.5±4.3g, 310.5±6.5g, 333.2±7.5g, 361.0±10.4g, 390.5±11.5g, 436.0±11.8g, 454.4±11.4g, 484.4±10.1g. Body weight of PG groups are decreased compared with those of control group, but the rates are not significant (Table 1).

Serum total cholesterol

Total cholesterol of control group(83.0±2.7 mg/dl) is much increased compared with that of normal group (65.8±2.3 mg/dl). Total cholesterol of PG group(77.2±3.3 mg/dl) is decreased by 7.0% compared with that of control group (Table 2).

Serum total cholesterol level of experimental group is decreased compared with that of control group, but the rates are not significant. This result suggests that if the obese index is high, serum total cholesterol is increased[12-14]. Therefore *Platycodon grandiflorum* extract may effect on the reduction of obesity.

Table 2. Effects on the Serum Total Cholestrol Level of Rats Fed High Fat Diet

Group	Total cholesterol(mg/ dl)	Decrease(%)
Normal	65.8±2.3 <sup>A)</sup>	
Control	83.0±2.7 <sup>###</sup>	
PG	77.2±3.3	7.0

<sup>A)</sup>: Mean ±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and adiministered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group.(<sup>###</sup>: P<0.001)

Decrease(%) : (Control - Sample)/Control×100.

Serum Triglyceride

Triglyceride is a combination of three fatty acids connected by esterification[3]. It is the chief element of every fatty tissue, and controls the energy preservation in body. Measurement of triglyceride level can also explain the cause of abnormal lipid metabolite[10].

The variation of serum triglyceride level may be the index of obesity because it is well known that if the obese index is high, serum triglyceride is increased [12,13]. Serum triglyceride of control group (130±7.0mg/dl) is much increased compared with that of normal group(71.0±5.7mg/dl). Serum triglyceride of PG group(103.6±9.0mg/dl) is decreased by 21.1% compared with that of control group (Table 3).

Table 1. Change on the Body Weight of Rats Fed High Fat Diet

Group (week)	Body weight (g)								
	0	1	2	3	4	5	6	7	8
Normal	234.1±1.9 <sup>A)</sup>	262.9±4.9	270.0±8.1	294.5±7.5	321.8±7.0	332.3±5.7	353.6±7.7	385.9±8.3	407.5±6.7
Control	243.5±2.2 <sup>#</sup>	288.4±8.1 <sup>#</sup>	331.7±11.6 <sup>###</sup>	359.5±12.2 <sup>###</sup>	386.6±9.2 <sup>###</sup>	409.1±14.5 <sup>###</sup>	453.0±13.0 <sup>###</sup>	481.5±15.1 <sup>###</sup>	517.7±13.2 <sup>###</sup>
PG	243.7±2.0	283.5±4.3	310.5±6.5	333.2±7.5	361.0±10.4	390.5±11.5	436.0±11.8	454.4±11.4	484.4±10.1

Normal : Group fed normal diet, Mean ±Standard Deviation.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon randiflorum* extract during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group. ( <sup>#</sup> : P<0.05, <sup>##</sup> : P<0.01, <sup>###</sup> : P<0.001 )

Table 3. Effects on the Serum Triglyceride Level of Rats Fed High Fat Diet

Group	Triglyceride(mg/ dl)	Decrease(%)
Normal	71.0±5.7 <sup>A)</sup>	
Control	130.5±7.0 <sup>###</sup>	
PG	103.0±9.0 <sup>*</sup>	21.1

<sup>A)</sup> : Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon grandiflorum* during 8 *Platycodon grandiflorum* 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group. (<sup>###</sup> : P< 0.001)

<sup>\*</sup> : Statistically significant difference with control group.(<sup>\*</sup> : P< 0.05)

Decrease(%) : (Control - Sample)/Control×100.

### Serum free fatty acid

Serum free fatty acid is only 4~5% of total fatty acid in lipid. It usually forms a combination with albumin, and is energy source of peripheral tissue[3]. It is measured excessively in a patient with obesity, diabetes or liver disease[3]. The higher the obese rate is, the higher the serum triglyceride density is[13,14].

Serum free fatty acid of control group (783.5±47.9 μEq/l) is much increased compared with that of normal group (599.5±10.0 μEq/l). Serum free fatty acid of PG group(630.1±45.9 μEq/l) is decreased by 19.6% compared with that of control group. And decreasing rate of PG group is significant (Table 4).

### Lipid

When an obese person loses the body weight, total lipid amount is decreased[14]. Total lipid amount of control group(432.4±45.2 mg/dl) is much increased compared with that of normal group(301.8±11.1 mg/dl). Total lipid amount of PG group(393.6±23.7 mg/dl) is decreased by 9.1% compared with that of control group. But decreasing rate of PG group is not significant (Table 5).

Table 4. Effects on the Serum Free Fatty Acid(FFA) Level of Rats Fed High Fat Diet

Group	FFA(μ Eq/ ℓ )	Decrease(%)
Normal	599.5±10.0 <sup>A)</sup>	
Control	783.5±47.9 <sup>#</sup>	
PG	630.1±45.9 <sup>*</sup>	19.6

<sup>A)</sup> : Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group. (<sup>#</sup> : P< 0.01)

<sup>\*</sup> : Statistically significant difference with control group. (<sup>\*</sup> : P< 0.05)

Decrease(%) : (Control - Sample)/Control×100.

Table 5. Effects on the Serum Total Lipid Level of Rats Fed High Fat Diet

Group	Total lipid(mg/ dl)	Decrease(%)
Normal	301.8±11.1 <sup>A)</sup>	
Control	432.8±45.2 <sup>#</sup>	
PG	393.6±23.7	9.1

<sup>A)</sup> : Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PAS : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group.(<sup>#</sup> : P< 0.05)

Decrease(%) : (Control - Sample)/Control×100.

### Serum Phospholipid

Phospholipid is related to many body functions such as the formation of cellular wall, emulsification or absorption of lipid, blood coagulation, choline metabolism, etc. It varies its level, when the lipidic metabolic disorder occurs[3].

Serum Phospholipid of control group(145.5±6.6 mg/dl) is much increased compared with that of normal group(124.2±4.2 mg/dl). Serum Phospholipid of PG group(132.4±3.9 mg/dl) is decreased by 9.0%compared

with that of control group. But decreasing rates of PG group is not significant (Table 6).

Serum HDL-cholesterol

HDL-cholesterol contributes to the elimination of cholesterol stored in body cells[3]. It is recently reported that HDL-cholesterol prevents arteriosclerosis[3]. And if the obese index is high, serum HDL-cholesterol is decreased[14,15].

Serum HDL-cholesterol of control group(61.4±1.9 mg/dl) is increased compared with that of normal group (51.7±2.6 mg/dl). Serum HDL-cholesterol of PG group(64.4±3.0 mg/dl) is increased by 4.9%, compared with that of control group. But decreasing rates of PG groups is not significant (Table 7).

Serum LDL-cholesterol

If the obese index of a person is high, LDL-cholesterol concentration of him is also high[9], and high lipid diet increases especially LDL-cholesterol concentration [15].

Serum LDL-cholesterol of control group(10.5±0.7 mg/dl) is much increased compared with that of normal group(8.1±0.4 mg/dl). Serum LDL-cholesterol of PG group(9.6±0.5 mg/dl) is decreased by 8.6% compared with that of control group. But decreasing rate of experimental group are not significant (Table 8).

Table 6. Effects on the Serum Phospholipid Level of Rats Fed High Fat Diet

Group	Phospholipid(mg/dl)	Decrease(%)
Normal	124.2±4.2 <sup>A)</sup>	
Control	145.5±6.6 <sup>#</sup>	
PG	132.4±3.9	9.0

<sup>A)</sup>: Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 7.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group. (<sup>#</sup> : P<0.05).

Decrease(%) : (Control - Sample)/Control×100.

Table 7. Effects on the Serum HDL- Cholesterol Level of Rats Fed High Fat Diet

Group	HDL-cholesterol(mg/dl)	Increase(%)
Normal	51.7±2.6 <sup>A)</sup>	
Control	61.4±1.9 <sup>#</sup>	
PG	64.4±3.0	4.9

<sup>A)</sup>: Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 7.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group.(<sup>#</sup> : P<0.01)

Increase(%) : (Sample - Control)/Control×100.

Table 8. Effects on the Serum LDL-Cholesterol Level of Rats Fed High Fat Diet

Group	LDL-cholesterol(mg/dl)	Decrease(%)
Normal	8.1±0.4 <sup>A)</sup>	
Control	10.5±0.7 <sup>#</sup>	
PG	9.6±0.5	8.6

<sup>A)</sup>: Mean±Standard Deviation.

Normal : Group fed normal diet.

Control : Group fed high fat diet and administered normal saline during 8 weeks.

PG : Group fed high fat diet and administered 5.26mg/100g extract of *Platycodon grandiflorum* during 8 weeks.

<sup>#</sup> : Statistically significant difference with normal group.(<sup>#</sup> : P<0.01)

<sup>\*</sup> : Statistically significant difference with control group. (<sup>\*</sup> : P<0.05)

Decrease(%) : (Control - Sample)/Control×100.

## Discussion

I carried out to investigate the effects of *Platycodon grandiflorum* (PG) on biochemical changes of rats fed high fat diet. I got the following result investigating the effects of PG observing the following variations of rats.: body weight, total cholesterol, triglyceride, free fatty acid, total lipid, phospholipid, HDL-cholesterol, L DL-cholesterol. The serum triglyceride, free fatty acid level in *Platycodon grandiflorum* group showed a significant

decrease in comparison with control group. When the lipid metabolism disorder occurs body weight, total cholesterol, triglyceride, free fatty acid, total lipid, phospholipid, HDL-cholesterol, LDL-cholesterol are abnormal. Summarizing these results, it seems likely that *Platycodon grandiflorum* may be used to prevent or cure the obesity induced by high fat diet.

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## 초록 : 도라지 추출물의 항비만 효과: 비만 흰쥐 체중변화와 혈청 Lipid Profile에 대한 도라지 추출물의 영향

변 부 형

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본 연구는 도라지 추출물의 항 비만 효과를 관찰하기 위하여 비만 흰쥐에 도라지 추출물을 투여 한 후, 비만 흰쥐의 체중 변화와 혈청 중의 지질 프로파일을 측정하였다. 그 결과 도라지 추출물의 투여는 실험 시작 후 1주부터 8주까지 대조군에 비하여 감소하는 경향을 보였다. 고지방식으로 비만을 유도하였을 때, 정상군 보다 total cholesterol, triglyceride, fatty acid, total lipid의 함량이 증가되던 것이 도라지 추출물의 투여로 total cholesterol, triglyceride, fatty acid, total lipid의 함량이 현저히 감소하는 경향을 나타냈다. PG군의 total cholesterol( $77.2 \pm 3.3$  mg/dl)은 대조군에 비해 약 7.0% 감소되었으며, PG군의 triglyceride( $103.6 \pm 9.0$  mg/dl)은 대조군에 비해 약 21.1% 감소되었다. 아울러 PG군의 fatty acid( $630.1 \pm 45.9$  uEq/L)함량은 대조군에 비해 약 19.6% 감소하였다. 또한 PG군의 경우 총 지질 함량은  $396 \pm 23.7$  mg/dl 이며, 이는 대조군에 비해 약 9.1% 감소하는 경향을 나타냈다. 이상의 결과로 미루어 보아 도라지 추출물은 비만의 개선 효과가 있을 것으로 생각되며, 앞으로 많은 연구가 병행하여야 할 것으로 사료된다.