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Suppressive Effects of Onion Peel Extract Tea in Experimental Obese Mice

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Abstract. In this study, it was examined the effects of onion peel tea (OPT) in a high-fat-diet-induced obese mouse model. Mice were fed a high-fat diet for 3 weeks, then a normal diet with or without OPT for 28 days. OPT suppressed the increase in body weight and level of epididymal fat tissue; it also significantly reduced the serum concentrations of total-cholesterol on day 14 and that of glucose and leptin on day 28. Our results indicate that OPT has anti-obesity effects in an experimental high-fat-diet-induced obese mouse model.

Keywords: Onion peel, tea, anti-obesity, leptin, functional food

1. Introduction

Obesity is a growing health problem worldwide, and it has been associated with metabolic syndrome (MetS), diabetes, cardiovascular disease, hypertension, and cancer [1]. The increasing incidence of obesity suggests that this epidemic will worsen in the future [2]. Animal models are useful tools to evaluate the efficacy of potential compounds for the prevention and treatment of obesity. It has been reported that rodents fed a high-fat diet are excellent models of obesity, in which the dietary environment is a major contributor [3].

It has been previously reported that some foods are beneficial for the suppression or prevention of MetS, including tea [4]. Green tea is already a popular beverage and can be easily incorporated as part of a diet designed to mitigate or prevent the symptoms of MetS [4]. Catechins, in particular, are one of the major polyphenolic compounds in tea and are beneficial for the treatment of the main MetS conditions, including obesity, type-2 diabetes, and cardiovascular risk factors [5]. Another potentially beneficial food is onion. Onion has the capacity to regulate lipid metabolism and suppress hyperglycemia and diabetes [6]. Many reports have attributed anti-obesity effects to quercetin, one of the flavonoids present in onion peel [7]-[9]. Tea extracted from onion peel (onion peel tea; OPT) could thus be expected to have beneficial effects for MetS.

In this study, we evaluated the anti-obesity effects of OPT in mice that were fed a high-fat diet. We also examined the effects of OPT on blood parameters in these mice [10].

2. Materials and Methods

2.1. Onion peel tea

Freeze dried OPT containing 1.15 mg/g quercetin (Saratto Tamatya, Fainaru, Tottori, Japan) was used in this study.

2.2. Animals and diets

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Twenty BALB/c mice (male, 4 weeks old) were purchased from CLEA Japan (Osaka, Japan). The animals were maintained under conventional conditions. The use of these animals and the procedures they were subjected to were approved by the Animal Research Committee of Tottori University. Throughout the experimental period, the mice had unrestricted access to food and water.

2.3. Study design

Mice were randomized into 2 groups; a control group and an OPT group (n = 10 mice per group). After habituation, all mice were fed a high-fat diet (HFD: High Fat Diet-32, CLEA Japan, Osaka, Japan) from day -21 to day 0. The control group was then fed a normal powdered diet (CE-2, CLEA Japan, Osaka, Japan) from day 0 to day 28, while the OPT group was fed a normal powdered diet supplemented with 5% (w/w) OPT. The mice were weighed every 7 days from day -21 to day 28.

Blood and epididymal fat tissue were harvested on days 14 and 28 (n = 5 at each time-point). Blood was collected via cardiac puncture under isoflurane inhalation anesthesia. After 1 h at room temperature, serum was recovered by centrifugation of the blood at 1,000 $\times g$ for 10 min at 4 ℃. The serum samples were stored at -80 ℃ prior to analysis. After blood collection, animals were immediately sacrificed by cervical dislocation, and their epididymal fat tissue was harvested and weighed.

2.4. Blood chemical analysis

Blood chemicals were measured using a blood chemical auto analyzer (DRY-CHEM 7000, FUJIFILM Inc., Tokyo, Japan). Serum triglyceride (TG), total-cholesterol (T-cho), glucose (Glu), alanine transaminase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), geranylgeranyltransferase (GGT), and albumin (Alb) levels were measured.

2.5. Measurement of serum leptin concentration

A sandwich enzyme-linked immunosorbent assay kit (MIoBS Inc., Yokohama, Japan) was used to measure leptin, in accordance with the manufacturer's instructions.

2.6. Statistical analysis

Statistical analyses were performed on all results by using Student's t-test or one-way ANOVA and the Tukey–Kramer test. All data are reported as mean ± S.D. A p value of <0.05 was considered statistically significant.

3. Results

3.1. Effects of dietary OPT on body weight and epididymal fat tissue

In the OPT group, mice were fed 5–6 mg/kg/day quercetin during the experimental period. During the experimental periods, the body weights of mice increased in both the control and OPT groups (Figure 1). In the OPT group, however, the gain in body weight was mitigated compared to that of the control group. On days 14 and 21 particularly, body weights in the OPT group were significantly lower than those of the control group ($p < 0.05$). The epididymal fat tissue weights were evaluated. On day 14, there was no significant difference between the control group (0.2 ± 0.0 g) and the OPT group (0.2 ± 0.1 g). On day 28, however, the mean epididymal fat tissue weight of the OPT group (0.3 ± 0.1 g) was significantly lower than that of the control group (0.5 ± 0.0 g) ($p < 0.01$).

3.2. Effects of OPT on blood chemical parameters

On day 28, the mean serum Glu concentration in the OPT group was significantly lower than that of the control group ($p < 0.01$). On day 14, however, there was no significant difference in serum Glu concentration between the groups. On day 14, the mean serum concentration of T-cho in the OPT group was significantly lower than that of the control group ($p < 0.05$). On day 28, however, there was no significant difference in mean serum T-cho concentration between the groups. On day 28, the mean serum ALP concentration in the OPT group was significantly higher than that of the control group ($p < 0.01$), although there was no difference on day 14. In the OPT group, mean serum TG concentrations were lower than those of the control group on days 14 and 28, although these differences were not statistically significant. There were no statistically significant differences between the groups with regard to serum concentrations of ALT, AST, GGT, or Alb, on days 14 or 28.

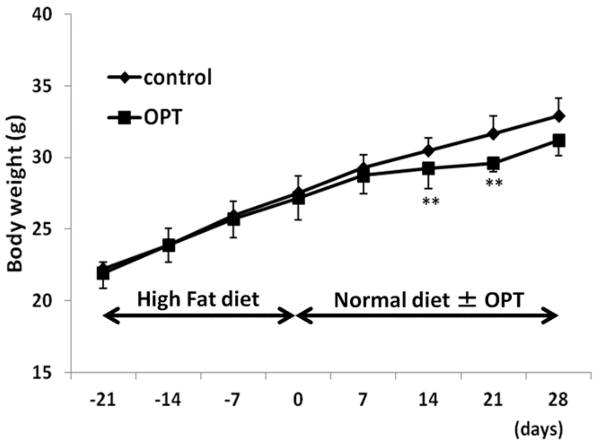

Fig. 1: Effects of OPT on body weight changes in diet-induced obesity model.

Data were shown by mean ± S.D. n=5, **:p<0.01 compared with the control group by student's t-test.

3.3. Effects of OPT on serum leptin levels

The leptin results are shown in Figure 2. On day 14, there was no significant difference between the control group (1.9 ± 0.5 ng/mL) and the OPT group (1.6 ± 0.2 ng/mL). The mean serum leptin concentration in the control group was significantly higher on day 28 than that on day 14 ($p < 0.01$). On day 28, the mean serum leptin concentration in the OPT group (2.7 ± 0.4 ng/mL) was significantly lower than that of the control group (4.9 ± 1.0 ng/mL) ($p < 0.05$).

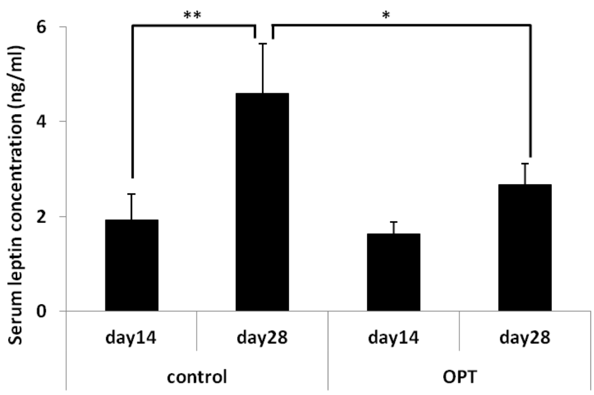

Fig. 2: Effect of OPT on serum leptin concentration.

Data were shown by mean ± S.D. n=5, **:p<0.01 by Turkey-Kramer's test.

4. Discussion

In this study, dietary OPT evidently suppressed the increase in body weight and level of epididymal fat tissue in an experimental mouse model. It has been reported that in rodents, a high-fat diet is a major contributor to obesity [3]. Our data indicated that dietary OPT can reduce body weight in an experimental high-fat-diet-induced obesity model.

Previous reports indicate that adipocytes in adipose tissue secrete a variety of proteins known as adipocytokines, including tumor necrosis factor-α, interleukin-6, resistin, leptin, and adiponectin [11]. Plasma leptin concentrations are positively correlated with adiposity (excessive body fat) and body weight changes in humans and rodents [12]. Adiponectin contributes to insulin sensitivity and fatty acid oxidation, and circulating concentrations of adiponectin are inversely correlated with body mass [13]. Our results indicate that OPT suppresses the secretion of leptin from adipocytes. Suppression of the secretion of leptin may have contributed to the reduction in body weight and the weight of epididymal fat tissue observed in the OPT group.

Quercetin is a major flavonol that is abundant in plant products, particularly onions, and it has been reported to possess antioxidative, anti-inflammatory, and lipid-regulating properties [14]. Numerous studies involving human clinical investigation, animal trials, and in vitro experiments have demonstrated that phenolic substances, including quercetin have important anti-inflammatory and anti-obesity properties [14]. OPT is rich in quercetin (1.15 mg/g). One possible mechanism by which OPT exerts anti-obesity effects may be the action of quercetin. In the previous reports, experimental animals were fed more amounts of quercetin than our study [9]. Our data suggest that another mechanism of action of OPT may exist. To understand additional mechanisms of action of OPT, analysis of all of the components of it may be required.

In conclusion, OPT suppressed the increase in body weight and epididymal fat tissue weight normally associated with a high-fat-diet-induced obesity model. It also significantly reduced serum levels of total-cholesterol and glucose. Furthermore, in the OPT group, the level of serum leptin on day 28 was significantly reduced. Collectively, our results indicate that OPT may be a potent functional food for the treatment, management, or prevention of obesity.

5. References

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