We identified an effect of \(\gamma\)-glutamylethylamide (theanine) on feeding in a rat study. Oral theanine suppressed the food intake of rats. The serum glucose level did not differ from the control, but the insulin concentration was reduced and the corticosterone concentration was increased by theanine. We suggest that the effect of theanine on feeding involved hormones.

Key words: theanine; amino acid; feeding; hormones

It has been reported that green tea has anti-obesity effects, and the addition of 2% green tea powder to the diet suppressed fat accumulation and body weight by reduction of food intake in mice.\(^{1}\) Zheng et al. attempted to identify tea components relating to anti-obesity, and suggested that catechins, caffeine, and theanine had anti-obesity effects.\(^{2}\) A previous study showed that the addition of theanine decreased total cholesterol and non-esterified fatty acids (NEFA) levels in rat serum. The food intake of rats fed the diet containing theanine tended to decrease, but not significantly.\(^{2}\) We noted the effect of theanine, \(\gamma\)-glutamylethylamide, on anti-obesity activity. Theanine is a unique amino acid in tea leaves and is contained abundantly in green tea. It has physiological effects such as anti-oxidation of LDL cholesterol,\(^{3}\) modulation of neurotransmission,\(^{4}\) neuroprotection,\(^{5}\) and anti-hypertension,\(^{6}\) and it has been suggested that it affects various hormones and neurotransmission. In this study, we identified an effect of a single oral theanine administration on the feeding behavior of rats and examined to determine which hormonal factors are involved in the anti-obesity effects of theanine.

Male Wistar strain rats (260–280 g in weight; SLC, Shizuoka, Japan) were kept individually in a temperature- and humidity-controlled room (24 ± 1°C and 55 ± 3% relative humidity) under regular lighting conditions (12 h light, 07:00–19:00; dark, 19:00–07:00). This experiment was carried out in accordance with the “Guidelines for the Care and Use of Laboratory Animals” of the University of Shizuoka, which refer to the American Association for Laboratory Animals Science. Rats could eat from 19:00 to the following 07:00 for 2 weeks, and then the following test was performed. There were six or eight rats in each group in all experiments. Statistical analysis was performed by Student’s \(t\)-test. In all cases, \(P < 0.05\) was considered significant. Results were expressed as the mean ± SEM.

Saline or saline containing theanine (0.4 g/100 g B.W.) was administrated p.o. at 18:30 and food intake, body weight change and serum glucose, and insulin level were measured (Fig. 1).

Theanine-administered rats showed reduced food intake and body-weight gain. The serum glucose concentration did not change remarkably, but the insulin concentration was reduced by theanine administration. We hypothesized that this reduction in food intake due to theanine contributed to the change of the locomotor
activity, and hence we performed an open field test under the same conditions (n = 8). The open field box was 70 cm × 70 cm × 40 cm height. The open field test was performed 1, 2, 4, and 6 h after theanine administration. The rat was placed in the open field box, and behavior was recorded for 5 min using a DV-Track video tracking system, CompACT VAS/DV (Muromachi Kikai, Tokyo). Locomotor activity was not changed by theanine administration (Fig. 1). We hypothesized that suppression of food intake by theanine contributed to the reduction in the serum insulin level, and hence we
performed an oral glucose tolerance test. Rats were reared under the same conditions as above. Saline or saline containing theanine (0.4 g/100 g B.W.) was administered p.o. at 18:30. Instead of the diet, all rats were administered a glucose solution (0.3 g/100 g B.W.) p.o. at 19:00.

In the glucose tolerance test, theanine administration reduced the serum insulin level similarly to the feeding test. In addition, the serum NEFA level change was moderated by comparing with the control group and the corticosterone level was increased remarkably by theanine administration (Fig. 2). In addition, we examined to determine whether theanine stimulates the peripheral nervous system (PNS). This experimental condition was the same as for the feeding test. We collected rat urine from 19:00 to 07:00 (12 h) and measured urinary norepinephrine and epinephrine concentrations.

Theanine (0.4 g/100 g B.W.) administration did not change their concentrations significantly, but they did tend to decrease (Fig. 3).

It is known that some amino acids and peptides modulate feeding behavior and contribute to homeostasis in animals. In this study, theanine administration decreased food intake. It hardly affected the serum glucose level, but the serum NEFA level change was suppressed significantly as compared with the control group. Sayama et al., suggested that the effect of theanine on feeding involves brain neurotransmission, such as dopamine and serotonin, but this has not been confirmed yet. Hence, we measured hormones related to feeding and glucose metabolism. Theanine administration changed serum insulin and corticosterone concentrations dramatically. It has been reported that insulin stimulates the satiety center directly and suppresses the appetite, but theanine administration reduced the insulin concentration. In this study, glucose administration decreased serum corticosterone but theanine administration increased the corticosterone concentration. Centrally, corticosterone stimulates feeding, and in the periphery it inhibits energy storage. In addition, it stimulates insulin secretion. This was an inconsistent result in this study. We hypothesize that other hormones or theanine itself participated in the regulation of feeding behavior. It has been reported that
catecholamines, such as norepinephrine and epinephrine, promote feeding. In this study, theanine administration reduced the urinary concentration of these hormones, but not significantly (Fig. 3). Nevertheless, this result confirms that theanine affected PNS or the vagus nerves and modulated feeding behavior.

In this study, we showed the effect of theanine on feeding behavior and some serum components in rats, but the possibility remains that some other amino acids have such effects. Thus, in further study, we intend to examine the effects of theanine as compared with that of other amino acids.

In conclusion, theanine administration suppressed food intake and changed the concentration of some hormones in rat serum. We conclude that theanine consumption is effective in the modulation of food intake. Because many factors mediate the satiety center, the mechanism of theanine was not identified in this study.

Acknowledgment

This work was supported in part by grants for scientific research from Shizuoka Prefecture, and, by the 21st Century COE program of the Ministry of Education, Culture, Sports, Science and Technology of Japan.

References