Effects of a Chicken Extract on Food-Deprived Activity Stress in Rats

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A water-soluble chicken extract is popularly consumed as a traditional health food. The studies made revealed that it could increase the survival time and inhibit the increase of locomotor activity in rats loaded with food-deprived activity stress. The mechanism for this might be related to an elevation of the brain histamine level, and the active ingredient, carnosine, might contribute to this effect.

Key words: chicken extract; food-deprived activity stress; histamine; rotational running

Chronic exposure to stressors directly affects the autonomic nervous system and hormones,1 suppresses the immune system,2 and causes acute damage to organ functions.3 Considering that stress is common in our life, it is important and urgent to find a way to alleviate the adverse effects of stressors in order to maintain a healthy life. It is well known that various foods are believed to affect physiological functions. For example, Brand’s essence of chicken (BEC), a water-soluble substance extracted from gently cooked chicken, is a popular health supplement and is consumed particularly in Chinese communities and Southeast Asia as a traditional health food. Studies have suggested that it enhanced mental efficiency and recovery from sickness and fatigue.4 The main functional ingredients of BEC are such substances as proteins and peptides (83.0 mg/ml), free amino acids (3.1 mg/ml), anserine (2.3 mg/ml) and carnosine (0.8 mg/ml),5 among which carnosine is thought to be the precursor of histamine.6 Studies have supported the notion that the activated histaminergic neuron system seems to work to prevent a stress-induced vicious cycle. We therefore used a chronic physio-psychological stress model, the food-deprived activity stress animal model, to investigate the effects of BEC on the activity stress, as well as on changes of the brain histamine level.

Seven-week-old male Sprague-Dawley rats were purchased from the Center of Laboratory Animal Science Research of Guangdong Province (Guangdong, China). The animals were kept in a specific-pathogen-free animal room at 23 ± 1 °C and humidity conditions of 50–70% with a 12-h light-dark cycle (lights on from 6:00 to 18:00) under dim white light (about 15 Lux). The rats were fed with a low-histidine laboratory diet (composition: moisture, 9.3%; crude protein, 25.1%; crude fat, 4.8%; crude fiber, 4.2%; nitrogen-free extract, 50.0%; and crude ash, 6.7%; <0.6 nmol histidine/g of food) before and during the experiments. The care and treatment were conducted in accordance with the Guide for the Care and Use of Laboratory Animals as adopted and promulgated by the United States National Institutes of Health. The food-deprived activity stress to the rats was applied in running wheel cages (Muromachi-Kikai, Tokyo, Japan). A one-way analysis of variance (ANOVA) was applied to analyze data differences in of the biochemical parameters among the experimental groups, this being followed by Dunnett’s test for pairwise multiple comparisons. Differences are considered as statistically significant at p < 0.05.

The first experiment was designed to test the effects of BEC on the survival time of rats under a condition of food deprivation and activity stress. These rats were permitted to take food and water for 2 h (17:00–19:00) in a side cage adjacent to the activity wheel, and were forced to run on the wheel for the remaining 22 h per day. The number of surviving animals in each group was recorded every day. As shown in Fig. 1, some of the rats in the survival experiment began to die on the 11th day of the experiment. On the 15th day, all the seven rats had died in the gelatin control group. However, one rat still survived until the 17th day in the BEC 2 ml/100 g group.

The second experiment was based on the first and was designed to detect the effects of BEC on the rotational frequency and histamine level in the brain. The rats were sacrificed under general anesthesia with diethyl ether on the 14th day of the experiment, and brain tissues were collected for a histamine analysis. The concentration of histamine in each brain region was determined by high-performance liquid chromatography (HPLC), using the derivation method.7 It is well known that BEC contains many ingredients, carnosine being one of its important functional ingredients. The third experiment was therefore designed to compare the effects of carnosine and BEC on the food-deprived activity stress.

As shown in Fig. 2, the rotational frequency remained consistently low for all rats from the 1st to 4th day of the experiment. After the 4th day, the rotational frequency
abnormally increased until the end of the experiment, which indicated the compulsion induced by food-deprived activity stress.8) The increase in rotational frequency was significantly inhibited by both a high and low dose of BEC ($p < 0.05$), especially during the dark phase of a daily cycle. As shown in Fig. 2C, there was no marked effect of gelatin on the locomotor activity of the rats compared with the water control group. A low and high dose of carnosine exhibited almost the same respective effect on the rotational frequency as a low and high dose of BEC. The effect of BEC on ameliorating the food-deprived activity stress might therefore be attributed to its functional ingredients, especially carnosine.

As shown in Table 1, the histamine contents of the hypothalamus, hippocampus and cortex significantly increased when the rats were forced to run on the wheels for 13 d ($p < 0.05$). There was also a significant

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Fig. 1. Effect of BEC on the Survival Rate of Rats Loaded with Food-Deprived Activity Stress.

Fig. 2. Effects of BEC and Carnosine on the Locomotor Activity Frequency of Rats Loaded with Food-Deprived Activity Stress.

A, Effect of BEC on the locomotor activity frequency of rats loaded with activity stress in the light phase of a daily cycle. B, Effect of BEC on the locomotor activity frequency of rats loaded with activity stress in the night phase of a daily cycle. The measured data are presented as the mean ± SE ($n = 7$). *$p < 0.05$ with respect to the gelatin control group. C, Comparison of the effects of carnosine and BEC on the locomotor activity frequency of rats loaded with activity stress. The gelatin control mice were administered with 7.2% gelatin in a 0.3% caramel solution which had the same caloric content as BEC of 2 ml/100 g. The results are presented as mean values obtained from seven rats in each group.
Carnosine and beta-alanyl-l-histidine, induction of histidine decarboxylase or to an enhanced histamine level might therefore have been due to the anticonvulsant effects in animals. This might be its pass across the blood brain barrier and exert its direct and interfere with the metabolism of histamine. It has recently been reported that carnosine could readily inhibit the degradation of histamine. These results might be its indirect effects against stress. In short, carnosine might exert its direct or indirect anti-stress effects via the histaminergic neural function in the brain. Taken together, BEC’s effects on the brain histamine level may be one of its important mechanisms for fighting chronic physio-psychological stress.

It has previously been reported that there is only 0.8 mg of carnosine in 1 ml of BEC. Taking carnosine as the only main active ingredient of BEC, carnosine at doses of 50 mg/kg and 200 mg/kg is equivalent to 6.25 ml/100 g of BEC and 25 ml/100 g of BEC. These doses are far greater than the doses of BEC (0.5 ml/100 g and 2 ml/100 g) used in our experiment. However, carnosine in doses of 50 mg/kg and 200 mg/kg had similar effects to the low doses of BEC (0.5 ml/100 g and 2 ml/100 g) as shown in Fig. 2C. The results of our previous studies have suggested that the main ingredients of BEC also exerted a protective effect against stress-induced elevation of the oxidative level in the plasma. It is therefore possible that such other ingredients as proteins and peptides, and such other effects of BEC as an antioxidant may also play very important roles in fighting chronic physio-psychological stress.

In summary, BEC increased the survival time and inhibited the locomotor activity of rats induced by long-term chronic food-deprived activity stress. The mechanism of BEC may be related to its elevation of the brain histamine level, and carnosine, one of BEC’s active ingredients, may contribute to an alteration of the brain histaminergic activity. The results also indicate that many other ingredients and such an effect as antioxidative of BEC should not be ignored. A regular supply of BEC might therefore be very helpful in fighting against the usual chronic stress in life and protecting people from diseases.

References