EFFECT OF PANAX GINSENG ROOT ON SPONTANEOUS MOVEMENT AND EXERCISE IN MICE

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Abstract—Effects on motor activities of normal and exhausted mice were studied on fractions obtained from Panax Ginseng root consecutively administered orally in small doses. Effects on motor activities were measured utilizing: hole cross (HC) test, and tests using phototransistor (PT) and spring (ST) recorders. Significant decreases in motor activities were observed in the GNS 100 mg/kg treated groups in the HC test and in 400 mg/kg treated mice in the PT test. Significant increases of motor activity were absent in both HC and PT tests, however, 10 mg/kg of GNo. 4 and TRg slightly increased locomotor activity in the PT test. A significant increase of locomotor activity in the ST test, was noted after the administration of GNo. 5 at a dose of 10 mg/kg. In the test using an activity wheel apparatus, GRg slightly decreased the number of light beam interruptions, and locomotor and rotating activities in the PT test. GF4 significantly increased the number of interruptions in the activity wheel, and decreased both activities in the PT test. Ten mg/kg of GNo. 3 and GNo. 5 significantly increased locomotor activity of the exercised mice.

The central stimulant and anti-fatigue activities of Panax Ginseng root have been well documented (1, 2, 3, 4, 5, 6). In a previous report by the present authors slight CNS-stimulant activity was indicated from the results of blind screening in water-extract, in a crude saponins fraction (GNo. 4) and in Ginsenoside Rg1 (7). In addition it was observed that Ginsenoside Rg1 and lypophilic fraction (GNo. 5) expedited the recovery from exhaustion in mice after a 4 hr oscillation period. The possibility, however, that a crude neutral saponins fraction (GNo. 3) accelerates recovery from exhaustion in animals also remains (8). In this paper, the effects of small doses of consecutively administered Panax Ginseng root extracts on spontaneous movement of normal and exhausted mice are reported. Three types of motor activity recorders and one activity wheel apparatus for enforced exercise were utilized for experiments.

MATERIALS AND METHODS

Preparation of various fractions from Panax Ginseng root

Extracts (GNo. 3, GNS, GNo. 4, Ginsenoside Rg (GRg), GF4, GNo. 5, GNo. 5–1 and GNo. 5–2) were obtained from Panax Ginseng C. A. Meyer grown in Nagano Prefecture, Japan. A detailed fractionation of these components is outlined in a previous report (7). GRg consists of Ginsenoside Rg1, Rg2 and Rg3, which is separated from GNo. 4. GNo. 5 is also separated into alkaline soluble (GNo. 5–1) and insoluble (GNo. 5–2) fractions. GF4 is obtained from the CHCl3-eluant of the column chromatography of GNo.
4 on silica gel, and dose not contain saponins. The solutions of GNo. 3, GNS, GNo. 4, G\textsubscript{RG} and GF\textsubscript{4} were prepared with physiological saline, and GNo. 5, GNo. 5-1 and GNo. 5-2 were suspended in saline with a drop of tween 80. Methamphetamine hydrochloride (MA), caffeine (CAF) used as complex with sodium benzoate in saline and meprobamate (MEP) suspended in saline with tween 80, were used as control.

**Behavioral pharmacological methods**

The following methods were employed to measure spontaneous movement in mice; 1) hole cross (HC) test described by Takagi et al. (9), 2) phototransistor recorder (PT) test and 3) spring recorder (ST) test. Details of the latter two apparatuses have been reported by Takagi et al. (10).

1) **Hole cross test (HC test)**

Groups of 5 male mice (ddY-strain), each weighing 18-20 g, were put into a test cage and observed for 4 days, 2 hr each day. Drugs had not be given the first day of observation. The observation on the following days was conducted 30 min after oral administration of drugs, at the same time of day and under the same conditions as the first test. Drugs were administered once a day for one week to the six test groups, and tests were conducted on these groups on the 1st, 4th and 7th (8th) days of the drug administration. Physiological saline was given to control groups. Motor activity of this test was calculated as the percent ratio of the number of test mice passing through the hole of the cage to the number of control (test on the 1st day without drugs: T/C >: 100).

2) **Test using phototransistor recorder (PT test)**

A single male mouse (ICR-strain), weighing 35-40 g, was put into a triangular test cage with 4 overhead lights, and locomotor activity (the number of times the mouse intercept of 4 vertical light beams), and rotating activity (the number of times the mouse ran corner to corner in the cage) were counted during a 1 hr period. The test schedule of this test and the following one was the same as that used in the HC test. The motor activity index was calculated in the same way T/C x 100.

3) **Test using spring recorder (ST test)**

A single male mouse (ddY-strain), weighing 18-21 g, was put into a triangular test cage and the number of movements of the tilting cage resulting from the changing weight of the mouse running to each corner, were counted for 1 hr.

**Forced exercise**

The activity wheel apparatus automatically rotated at a speed of 6 rpm, when used to exercise the mice. The apparatus shown in Fig. 1, consisted of a cylindrical cage, 20 cm in diameter and 6 cm in width, both sides made of transparent plastic plates, the outside being made of metal netting. One male mouse (ddy-strain), weighing 35-40 g, was put into the cage and forced to run on the net for 2 hr. A light and phototransister are set up in opposite positions at the top of a cylinder at a height of 19 cm. When the mouse passed through the top of the cylinder, taking hold of net, the light beam was cut off and the movement was recorded on the kymograph. The number of light beam interruptions
was calculated as the index of fatigue. After 2 hr of running exercise, the PT test was performed. Drugs were given orally once a day for one week before the 2 hr exercise. Tests were done on the mice on the 1st, 4th and 7th days of the week.

RESULTS

The HC test was performed 30 min after the administration of 10 and 100 mg/kg of GNo. 3, GNS, GNo. 4, GRg, GNo. 5, GNo. 5-1 and GNo. 5-2. A significant decrease in motor activity in mice given 100 mg/kg of GNS was observed on the 1st day. No difference in motor activity was observed between the test and the control groups in the other 13 groups (Fig. 2).

In the PT test, MA 1.5 mg/kg i.p. treated groups significantly increased both locomotor and rotating activities, and MEP 50 mg/kg i.p., decreased these activities. GNS at a dose of 400 mg/kg significantly

![FIG. 1. Activity wheel apparatus for enforced exercise.](image)

![FIG. 2. Effect of GNS on spontaneous movement in mice, using HC test.](image)

![FIG. 3. Effect of GNS on spontaneous movement in mice, using PT test.](image)
decreased both activities on the 1st day (Fig. 3). A slight decrease of both locomotor and rotating activities was observed after the administration of GNo. 5-2 at a dose of 10 mg/kg. Ten mg/kg of RGg and GNo. 4 slightly increased locomotor activity on the 6th and 7th days, but had no effect on rotating activity (Fig. 4). Ten and 100 mg/kg of GNo. 3, GNS and GNo. 5, and 10 mg/kg of GNo. 5-1 had no influence on these activities.

![Graph showing effect of GNo. 4 and GRg on spontaneous movement in mice.](image1)

**Fig. 4.** Effect of GNo. 4 and GRg on spontaneous movement in mice, using ST test.

- ○ - control
- ● - GNo. 4 or GRg, 10 mg/kg

Each value is the mean of values obtained from 12 mice.

![Graph showing effect of GNo. 5 and GRg on spontaneous movement in mice.](image2)

**Fig. 5.** Effect of GNo. 5 and GRg on spontaneous movement in mice, using ST test.

- ○ - control
- ● - GNo. 5 or GRg, 10 mg/kg

Each value is the mean of values obtained from 10 mice.
FIG. 6. Effect of methamphetamine, caffeine and meprobamate on enforced exercise in mice.

A. Activity wheel test

B. PT test after enforced exercise

B 1. Locomotor activity

B 2. Rotating activity

In the ST test, significant increase of locomotor activity was observed after the administration of GNo. 5 at a dose of 10 mg/kg. Slight increase in activity was also noted in the group treated with GRg 10 mg/kg. Influence on spontaneous movement with 10 mg/kg of GNo. 3, GNS, GNo. 4, GNo. 5-1 and GNo. 5-2 was not observed (Fig. 5).

In the test on exhausted animals, i.p. injection of 10 mg/kg of CAF and 1.5 mg/kg of MA before the 2 hr exercise, significantly decrease the number of light beam interceptions and increased both locomotor and rotating activities. MEP at a dose of 15 mg/kg i.p., had no influence on the number of the activities. See Fig. 6.

Ten mg/kg of GRg slightly decreased the number of light beam interruptions on the
4th and 8th days, however, GF4 at a dose of 10 mg/kg increased the interruption on all the test days. Ten mg/kg of GNo. 3, GNS, GNo. 4, GNo. 5, GNo. 5-1 and GNo. 5-2, and 5 mg/kg of GF4 and GNo. 5 had no influence on the light beam interruptions. In the PT test after the exercise, GNo. 3 at a dose of 10 mg/kg, significantly increased locomotor activity on the 4th and 8th days, and GNo. 5 increased rotating on the 1st day. Ten mg/kg of GRg and 5 and 10 mg/kg of GF4 significantly decreased both activities on the 1st and 4th days. GNo. 4 at a dose of 10 mg/kg on the 4th and 7th days slightly decreased both activities. Ten mg/kg of GNS, GNo. 5-1 and GNo. 5-2 and 5 mg/kg of GNo. 5 had no influence on these activities (Fig. 7).
DISCUSSION

Effect of various fractions obtained from Panax Ginseng root consecutively administered in small doses, on motor activity and exhaustion in mice, was studied to determine CNS stimulant and anti-fatigue activities. A summary of the results is presented in Table 1. Three tests were used to measure the motor activity of mice. The HC test was used to measure spontaneous movement of grouped mice, hypothesizing that the potentiating effect of CNS stimulant action was caused by aggregation. A significant increase in motor activity in any fraction was not apparent. The PT test was used to measure 2 kinds of motor activity, locomotion and rotation. A significant increase in motor activity after the administration of all fractions was unobserved. A slight increase of locomotor activity was noted in groups treated with GNo. 4 and GRg. The ST test also used to measure locomotor activity as was the PT test. The ST test differentiated from the PT test, in that the test was made to incline toward three sides with the weight of the mouse. Significant increase in locomotor activity was observed in the GNo. 5 10 mg/kg treated group and slight increase was noted in the GNg 10 mg/kg treated group. GNS, 100 mg/kg treated groups in the HC test and 400 mg/kg treated mice in the PT test revealed a significantly decreased motor activity. To distinguish exact pharmacological characteristics among the three tests is most difficult. In the ST test, the movement of the cage will stimulate the mouse and increase alertness.

An activity wheel apparatus was used as the means of enforcing exercise. The PT test measured locomotor activity after the 2 hr exercise period. The number of intercepts of the light beam at the top of activity wheel was counted. Ten mg/kg of GRg slightly decreased the number, while 10 mg/kg of GF, increased the number. Other fractions had no effect. It appears that GRg may have anti-fatigue activities. The decrease of the number was utilized as an index of anti-fatigue activity, however, evaluation of these results is extremely difficult. Further study is now in progress. In the PT test, a sig-
nificant increase of locomotor and rotating activities was recognized in GNo. 3 and GNo. 5 treated groups. On the contrary, GRg and GF, decreased both locomotor and rotating activities. GNS and GF, were recognized as having mild CNS depressant activities. (11). Differences in body weight between control and test groups after the test period were unobserved. Ginsenoside RgL, GNo. 5 and GNo. 3 were determined to accelerate the recovery from exhaustion in mice (8). These results confirm previous studies made by the authors.

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