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The Effect of *Ferula moschata* Extract on the Physical Activity of Animals

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Abstract This article outlines detailed explanations of the results of experiments conducted after 1, 7, and 14 days on the physical activity of rats, as well as the duration of recovery for the 14th and 21st days after the cessation of administration of the alcoholic extract of *Ferula moschata* in doses of 100 and 200 mg/kg [9], are provided. The obtained results indicate an increase in the effect of the plant extract on the physical activity of animals.

Keywords *Ferula moschata*, Extract, Physical activity

1. Introduction

Ferula turcomanica, belonging to the order Apiales and the family Apiaceae, also known as Umbelliferae [1,2,3,4,5,6], is recognized for its resinous, volatile oil, bitter taste, medicinal properties, aromatic nature, and as a source of starch. These plants have historically been valued for their medicinal properties, with resin (gum) stored in their roots and stems. Various communities have long used them as medicinal herbs. One such species within this family is *Ferula moschata*, also known as Ferula sumbul [7].

Ferula moschata, also known as Sumbul, is a perennial herbaceous plant. While it is not commonly used for its rhizomes, extracts derived from it have been reported to contain approximately [7] 10.17% moisture, 7.70% starch, 10.60% pentosan, 17.15% fiber, 5.50% ashes, 1.40% dextrin, 1.64% sucrose, 0.51% reducing sugars, 1.10% volatile oil, and 17.1% resin. In traditional medicine, Sumbul is often prescribed for various conditions including flatulence, bronchitis, and spasms of the muscles.

The aim of this work was to investigate the effects of *Ferula moschata* extract on the physical activity of animals.

2. Materials and Methods

For the research, the alcoholic extract of *Ferula moschata*, laboratory rats, and a comparative preparation in the form of Eleutherococcus were chosen [8]. The *Ferula moschata* alcoholic extract is being studied for its impact on the strength characteristics of rat paws using the "grasping force" test, for its effect on body balance in animals using the "Rota-rod" rotating rod apparatus, and for its influence on physical activity through the "forced swimming" test. Each test involved four groups of animals: Group 1, the control group; Group 2, animals receiving a dose of 100 mg/kg of *Ferula moschata* extract; Group 3, animals receiving a dose of 200 mg/kg of *Ferula moschata* extract; and Group 4, animals receiving a therapeutic dose of 200 mg/kg of Eleutherococcus preparation. The experimental groups of animals were subjected to a 14-day study period, while the control group animals were given clean water. The experiments on physical activity were conducted on days 1, 7, and 14. All experiments involving animals were carried out in strict compliance with the bioethical standards of the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes, ensuring the welfare of the animals involved.

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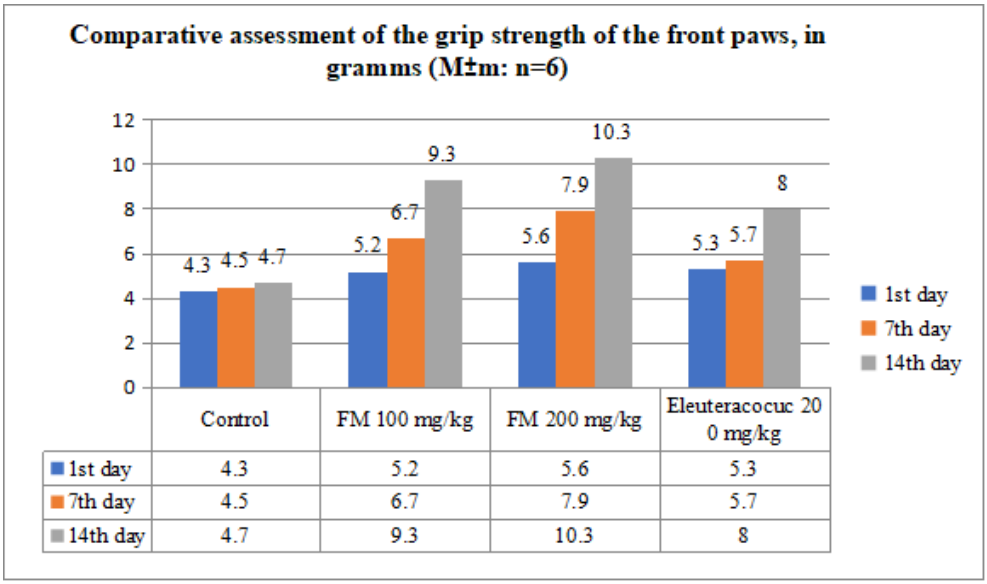
3. Results and Discussions

Indicators of grip strength (muscle compression force) of the forepaws were determined by intragastric administration of *Ferula moschata* extract (FM) and a comparative pharmacopoeial drug Eleutherococcus to rats for 14 days, as well as the compression force of their muscles on the 1st, 7th and 14th days of the experiment using a grip Strength meter test. The results of the study are presented in table 1 below.

The experimental results showed that after 1-day administration of the FM at doses of 100 and 200 mg/kg and comparative drug Eleutherococcus to rats at a dose of 200 mg/kg, when examined in the "Grip Strength Meter" test, the grip indicators of the forepaws showed a result of 5.2 ± 0.31, 5.6±0.42 and 5.3±0.49, respectively ($R<0.05$).

Table 1



	Control	FM 100 mg/kg	FM 200 mg/kg	Eleuteracocuc 200 mg/kg
1st day	4.3	5.2	5.6	5.3
7th day	4.5	6.7	7.9	5.7
14th day	4.7	9.3	10.3	8

When 100 and 200 mg/kg of FM extract, a comparative preparation of Eleutherococcus, were administered to rats at doses of 200 mg/kg for 7 days, the grip strength of the forepaws showed significantly higher indicators, and with results of 6.7±0.67, 7.9±0.27 and 5.7±0.56, respectively. All experimental groups differed from the control groups by 4.5±0.22, which have statistically significant differences ($r<0.01$; $R<0.001$; $R<0.05$).

On the 14th day of the experiment, the grip strength of the forepaw of the control group animals during the test was 4.7±0.33. At doses of 100 and 200 mg/kg of FM extract, this indicator was significantly higher and reached to 9.3±0.49 and 10.3± 0.67, while the comparative Eleutherococcus preparation showed a higher yield at a dose of 200 mg/kg (8.0± 0.26). All groups showed statistically significant differences compared to the control group ($p<0.001$).

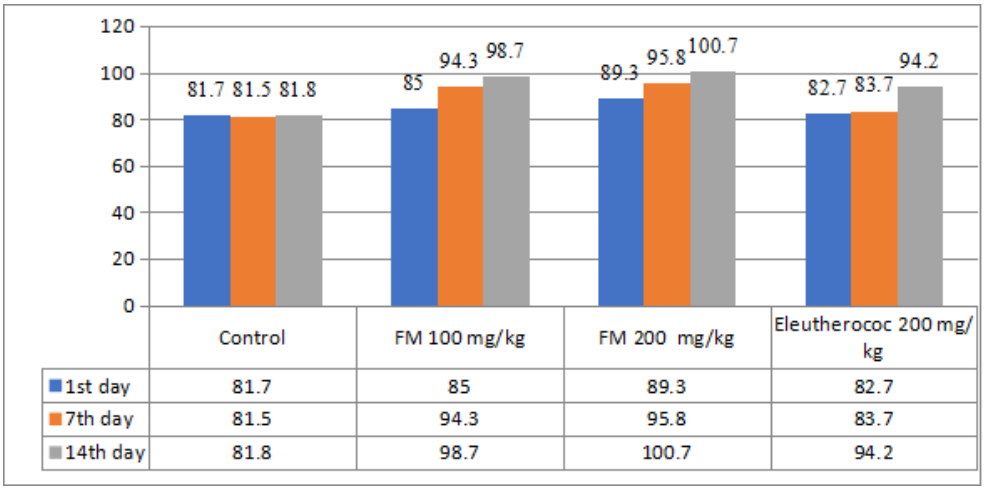
Thus, a comparative analysis of the "Grip Strength Meter" test showed that when FM extract was administered to rats at doses of 100 and 200 mg/kg for 14 days, FM at a dose of 100 mg/kg and the drug Eleutherococcus had an effect on the grip force of the front paws on the 1st day, but did not increase significantly compared to the control. However, at the FM 200 mg/kg dose, there was a statistically significant difference compared to the control. The results obtained with doses of 100 and 200 mg/kg of FM extract did not acquire statistical significance either individually or when compared with the Eleutherococcus preparation.

Activity increased during 7th and 14th days of the experiment, reaching statistically significant differences compared to the control, and this activity was also observed in the comparative Eleutherococcus pharmacopoeial preparation. When the results of the FM extract at doses of 100 and 200 mg/kg were compared, it was possible to observe that the effect range was almost identical. Compared to the FM extract at a dose of 100 mg/kg with the Eleutherococcus preparation, as well as compared to the FM extract at a dose of 200 mg/kg with the Eleutherococcus preparation, there was statistically significant activity increase ($p<0.05$, $p<0.01$).

In the second part of our experiment, the animals were subjected to the "Rota-rod" apparatus, with the aim of assessing their balance and coordination activities. Enhancing motor coordination is a complex aspect of behavioral neuroscience, as it can reflect balance, muscle strength, and motor activity, as well as sensory competence. In this setup, the animals were placed on a rotating rod, and the time until they fell off was recorded, allowing for the assessment of their performance. The average indicators of the obtained results are presented in the following table 2.

In the coordination test using the "Rota-rod" apparatus, rats administered with doses of 100 and 200 mg/kg of FM extract showed balance and motor coordination activity on the first day of the experiment at 85.0±0.71 and 89.3±0.8 seconds, respectively, while the group administered with 200 mg/kg of the comparative Eleutherococcus preparation exhibited a result of 82.7±0.71 seconds. The control group showed an average performance of 81.7±0.49 seconds. Although the group administered with Eleutherococcus 200 mg/kg showed higher performance compared to the control group, it did not reach statistical significance. However, the remaining experimental groups achieved statistically significant differences compared to the control ($p<0.001$). When comparing the results of doses of 100 and 200 mg/kg of FM extract, the effect of FM extract at a dose of 200 mg/kg was higher, showing statistically significant value ($p<0.001$). When comparing the FM extract at a dose of 100 mg/kg with the Eleutherococcus preparation, as well as when comparing the FM extract at a dose of 200 mg/kg with the Eleutherococcus preparation, the activity showed statistically significant value, indicating an improvement in both doses of FM extract ($p<0.05$, $p<0.001$).

Table 2



During 7th and 14th days of the experiment, the activity in maintaining balance of the rats was significantly higher in the groups administered with doses of 100 and 200 mg/kg of FM extract compared to the control group, with statistically significant differences observed ($p<0.001$). The comparative Eleutherococcus preparation at a dose of 200 mg/kg showed higher activity on the 7th day, but did not reach statistically significant value compared to the control. However, on the 14th day, the Eleutherococcus preparation at a dose of 200 mg/kg exhibited statistically significant differences compared to the control ($p<0.001$).

On the 7th day, the results at doses of 100 and 200 mg/kg of FM extract did not show significant differences when compared to each other. However, on the 14th day, the FM extract at a dose of 200 mg/kg was significantly higher than the dose of 100 mg/kg ($p<0.001$).

In both the 7th and 14th days, when comparing the FM extract at a dose of 100 mg/kg with the Eleutherococcus preparation, as well as when comparing the FM extract at a dose of 200 mg/kg with the Eleutherococcus preparation, the activity showed statistically significant value, indicating an improvement in both doses of FM extract ($p<0.001$).

During the 1st, 7th, and 14th days of the experiment, rats were subjected to a rotating drum to assess their voluntary motor activity, and the average number of revolutions made by the animals during 1 hour was recorded as a measure of their voluntary activity. The obtained results of the experiment are presented in the following table 3.

Table 3. Comparative evaluation of the activity level of the rats in the activity wheel test, (Mean±m; n=6)

Day	Control group	FM extract 100 mg/kg	FM extract 200 mg/kg	Eleutherococcus 200 mg/kg
1	38,3±0,42	40,5±0.76	42,8±0.40	39,5±0.85*
7	38,7±0.61	44,8±0.6*	46,0±0,58*	41,3±0,56*
14	39,0±0.63	49,3±0.80*	50,2±0,70*	43,5±0.85**

Note: *p<0.05; **p<0.01; ***p<0.005 - indicates significance compared to the control group.

According to the results of the experiment, the voluntary activity of the rats in the rotating drum for 1 hour in the control group led to an average of 38.3±0.42 revolutions. When administered at the doses of 100 and 200 mg/kg of FM extract for 1 day, their activity levels were 40.5±0.76 and 42.8±0.49, respectively, showing statistically significant differences compared to the control group ($p<0.05$, $p<0.001$). The comparative Eleutherococcus preparation at a dose of 200 mg/kg resulted in the activity of 39.5±0.85 revolutions, indicating an increase in the activity, but it did not reach statistically significant value compared to the control group. However, compared to the Eleutherococcus preparation at a dose of 200 mg/kg, the FM extract at doses of 100 mg/kg, and 200 mg/kg showed significantly higher activity levels ($p<0.01$, $p<0.001$).

On the 7th day of the experiment, when this procedure was repeated, the voluntary activity of the animals administered with the doses of 100 and 200 mg/kg of FM extract, and the comparative Eleutherococcus preparation at a dose of 200 mg/kg, resulted in activity levels of 44.8±0.60 and 46.0±0.58, and 42.0±0.52 revolutions, respectively. This was in contrast to the control group (38.7±0.61 animals), and there were observed statistically significant differences in the obtained results ($p<0.001$; $p<0.001$, $p<0.01$).

On the 14th day of the experiment, when the total number of revolutions in the rotating drum for all experimental animals was compared, it was found that the activity levels were 49.3±0.80, 50.2±0.70, and 43.5±0.85 revolutions, respectively, for the groups administered with doses of 100 and 200 mg/kg of FM extract, and the comparative Eleutherococcus preparation at a dose of 200 mg/kg. This was significantly higher compared to the control group (39.0±0.63 animals), with the statistically significant value ($p<0.001$).

On both of the 7th and 14th days of the experiments, compared to Eleutherococcus preparation, the FM extract at doses of 100 mg/kg, and 200 mg/kg, showed statistically significant value in the activity, indicating an improvement

in both doses of the FM extract ($p<0.001$). However, on the 7th and 14th days of the experiment, the FM extract at a dose of 200 mg/kg did not show statistically significant activity compared to the FM extract at a dose of 100 mg/kg.

4. Summary

1. In evaluating grip strength using the Grip Strength Meter test, when FM extract was administered to rats at doses of 100 mg/kg for 100 and 200 mg/kg for 14 days, as well as Eleutherococcus extract at a dose of 200 mg/kg, a statistically significant effect was observed only on the 1st day of the FM extract at a dose of 200 mg/kg. On the 7th and 14th days of the experiment, all groups showed increased activity compared to the control, reaching statistically significant value.
2. On the 1st and 7th days of the Rota-rod coordination test, when FM extract was administered at doses of 100 and 200 mg/kg and comparative Eleutherococcus extract at a dose of 200 mg/kg, the activity of movement in equilibrium in rats showed a higher result at both doses of FM than that compared to the control group, and a statistically convincing difference was achieved. On the 14th day of the experiment, activity in all groups increased at the level of statistical accuracy.
3. The activity of movements in the rotating wheel in experimental rats reached statistically significant differences on the 1st day of the study due to an increase in the number of revolutions in the wheel compared ещ the control group of animals at doses of 100 and 200 mg/kg of the FM extract. On the 7th and 14th days of the experiment, activity in all groups increased at the level of statistical accuracy.

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