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Original Article

Exploring Antidepressant and Skeletal Muscle Relaxant Effects of the Hydroalcholic Extract of the *Sedum lineare* Thunb.

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ABSTRACT

Background: *Sedum lineare* is a perennial succulent plant that is a member of the family Crassulaceae. **Objectives:** The present study desired to explore the antidepressant and muscle relaxant activities of hydroalcoholic extract of *Sedum lineare* Thunb. **Materials and Methods:** Male Swiss Albino mice were selected and distributed on different groups and administered with extracts of various doses. The forced swim test, tail suspension test, grip strength test and inclined plane test were conducted. **Results:** The forced swim test showed a reduction in the immobility time, i.e., 124.6±1.32, 98±0.72 and 84.4±1.20 at a dose of 100 mg/kg, 250 mg/kg and 500 mg/kg. The tail suspension test also presented reduced immobility time, i.e., 128±1.61, 117.4±0.96, 104.4±0.63 in 100 mg/kg, 250 mg/kg and 500 mg/kg, respectively. The grip strength test showed a decrease in time to fall from the wire, i.e., 33.4±0.92, 19.2±0.86 and 15.2±0.86 in 100 mg/kg, 250 mg/kg and 500 mg/kg, respectively. Time in the inclined plane also reduced, i.e., 20.8±1.24, 17.2±0.58, 14.8±1.06 in 100 mg/kg, 250 mg/kg and 500 mg/kg, respectively. **Conclusion:** Hydroalcoholic extract of *Sedum lineare* Thunb possesses depression and muscle relaxant activities.

Keywords: *Sedum lineare* Thunb, Anti-depressant, Muscle relaxant, Forced swim test, Tail suspension test.

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INTRODUCTION

Two of the health issues that are presently facing the risk of confronting serious obstacles are disorders that impact the musculoskeletal system and disorders that are associated with depression.[1] As a consequence of this, it is essential to conduct research on a wide range of potential possibilities in order to create novel treatment approaches. Although it is more well known as Carpet Stonecrop, *Sedum lineare* is a perennial succulent plant that is a member of the family Crassulaceae.[2,3] It is also known as Carpet Sedum, which is another word that is frequently used to refer to this plant. A large portion of the native population of this species may be found in Asia, which encompasses some regions of China and Mongolia. The herb Sedum lineare has been utilized for a great amount of time in the field of traditional folk medicine and it has been administered for its therapeutic properties for a long amount of time now.[4]

In addition to its mat-forming, low-growing morphology, dense, tiny, fleshy leaves and thick, creeping stems, *S. lineare* is distinguished by its characteristics because of its physical characteristics. Among these characteristics is the fact that it may be shaped into a mat. The fact that it is able to live in a wide variety of environments, including dry regions and rock surfaces, was demonstrated to be the case. This is evidence of its high level of resilience and its capacity to adapt to a number of circumstances.[5] Even while its traditional application involves the treatment of a broad variety of ailments that affect the digestive, cutaneous and respiratory systems, it is also well-known for the analgesic, anti-inflammatory and calming capabilities that it has. This is because it contains all of these properties. On the other hand, a rising number of studies are being conducted in order to investigate the potential role that the plant plays in the development of mental health illnesses as well as abnormalities in the working muscles.[6]

However, despite the fact that Sedum lineare has been utilized for a broad variety of traditional purposes over the course of many years, there has been a relatively small amount of study done out in the field of pharmacology on this plant. This is despite the fact that *Sedum lineare* Thunb. has been utilized.[7] Despite the

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fact that the data that is now accessible has already indicated the critical components that are present in the sedum, this continued to be the case. Compounds such as alkaloids, flavonoids and phenolic glycosides are all examples of substances that are classified as belonging to this group or department of chemicals. Given that a significant number of them have the ability to exert a variety of effects, such as the capacity to be neuroprotective, anti-inflammatory and antioxidant, it is quite possible that a significant number of pharmaceuticals could be manufactured with the assistance of the sedum. This is because the sedum has the ability to exert these effects.[8]

As a result of the numerous applications that have been accumulated over the course of history and the beginning of a wave of interest from the scientific community, *Sedum lineare* has the potential to become an outstanding subject for researchers to investigate. Because of the fact that it has the potential to become an exceptional subject for inquiry, this is the reason why it is noteworthy.[9] Millions of individuals all over the world continue to suffer from depression, making it one of the most prevalent illnesses that continue to affect everyone. In addition to this, it is one of the challenges that continue to be one of the most challenging illnesses to manage. There are a number of factors that contribute to this reality, one of which is the limited efficacy of the pharmacotherapies that are now accessible. In addition, there are negative consequences that are connected with musculoskeletal problems.[10]

The objective of this study is to first investigate the therapeutic effects of *Sedum lineare* on a variety of animal models and behaviours and then to validate those effects in the potential future. This is of the highest relevance, taking into mind the difficulties that have been mentioned up to this point in time. This investigation is being conducted with the intention of acquiring a more comprehensive comprehension of the pharmacological processes that are associated with the use of the drug. The use of stringent experimental and monitoring techniques will be executed in order to accomplish this goal. The investigation will place a special emphasis on the potential role that the medication might play in the treatment of depression as well as the relaxation of the muscles.[11] This will be done in order to ensure that the investigation is properly conducted.

As a result of the ongoing inquiry, there is a chance that novel drugs might be developed for the treatment of musculoskeletal disorders as well as depression. It is feasible to do this by combining the historical data with the research approaches that are currently being utilized. Furthermore, the potential implementation of this one-of-a-kind pharmaceutical in the future has the potential to address therapeutic gaps that are already present within the industry, while simultaneously enabling the deeper incorporation of indigenous medicines into the practice that is already in place that is a significant advantage.[12]

MATERIALS AND METHODS

Plant Material

Sedum lineare Thunb specimens were gathered from the Pune region of Maharashtra, India, in December 2022. The botanical identity of the specimens was verified by Dr. Gaurav Nigam from the herbarium of the Botany Department, Institute of Basic Science, Bundelkhand University. The reference voucher, authenticated as voucher [B.U./Bot./PhD./2022/001], was obtained. The collected material was air-dried and then pulverized into a fine powder.

Extraction

Hydroalcoholic extraction was performed using a solvent blend comprising ethanol and water in a ratio of 70:30 (v/v). The Sedum lineare marc underwent extraction, followed by filtration through Whatman filter paper no. 1 and concentration through evaporation. The resulting crude extract was stored in glass vials at 4°C, with its weight documented.[13]

Animal Subjects

Male Swiss Albino mice, weighing between 25-30g, were employed for the study.[14] They were supplied with standard animal feed pellets (Amrut feeds, New Delhi) and had access to municipal water ad libitum. Animal housing conditions conformed to CPCSEA guidelines (No.:- 716/GO/Re/S/02/CPCSEA), maintaining a temperature of 22±2°C with a 12 hr light/dark cycle. Ethical standards were strictly adhered to minimize any potential pain or discomfort during the experiments.

Antidepressant Study

Forced Swim Test (FST)

Mice were subjected to the Forced Swim Test (FST) in a cylindrical container containing water at 25±1°C. The duration of immobility during the final 4 min of the 6 min testing period was meticulously noted. Immobility was operationally defined as the absence of movement, except for necessary actions to keep the head above water level. A reduction in immobility time was interpreted as a potential indicator of antidepressant activity.[15,16]

Tail Suspension Test (TST)

For the Tail Suspension Test (TST), mice were individually suspended 60 cm above the surface of a table using adhesive tape affixed 1 cm away from the tail tip. Following a 1 min acclimatization period, the duration of immobility was observed over a period of 5 min. Mice were deemed immobile if they remained suspended passively without any discernible movement. [17,18]

Skeletal Muscle Relaxant Study

Grip Strength

Grip strength was assessed employing a grip strength meter.[19] Mice were tasked with gripping a steel wire positioned 50 cm above a cushion support using their forepaws. The duration each mouse sustained its grip before falling off was meticulously recorded as an indirect measure of grip strength.[20]

Inclined Plane

The inclined plane test assessed skeletal muscle relaxant activity. Mice were positioned on a transparent glass plane inclined at 30º and the time taken for them to slide off without intentional movement was measured.[21] Investigations were conducted at 15-30 min intervals post-administration of control, standard and extract, with a 30 sec time limit for hanging on or falling off the inclined plane.[22]

Statistical Analysis

The values, which were expressed as Mean±SEM for five mice, were subjected to analysis of variance (ANOVA), which was then followed by Dunett's *t*-test.[23]

RESULTS

Antidepressant Study

Forced Swim Test (FST)

In the Forced Swim Test (FST), mice treated with *Sedum lineare* Extract (SLE) exhibited a dose-dependent decrease in immobility time compared to the control group. The control group, receiving saline, showed an average immobility time of 146.2±1.14 sec. In contrast, the standard group treated with Imipramine, a known antidepressant, displayed significantly reduced immobility, with an average time of 63.4±0.82 sec. Mice treated with SLE at doses of 100 mg/kg, 250 mg/kg and 500 mg/kg demonstrated reduced immobility times of 124.6±1.32 sec, 98±0.72 sec and 84.4±1.20 sec, respectively. These results indicate a progressive reduction in immobility time with increasing doses of SLE, with all doses showing statistical significance compared to the control group ($p<0.05$) shown in Table 1, Graph 1.

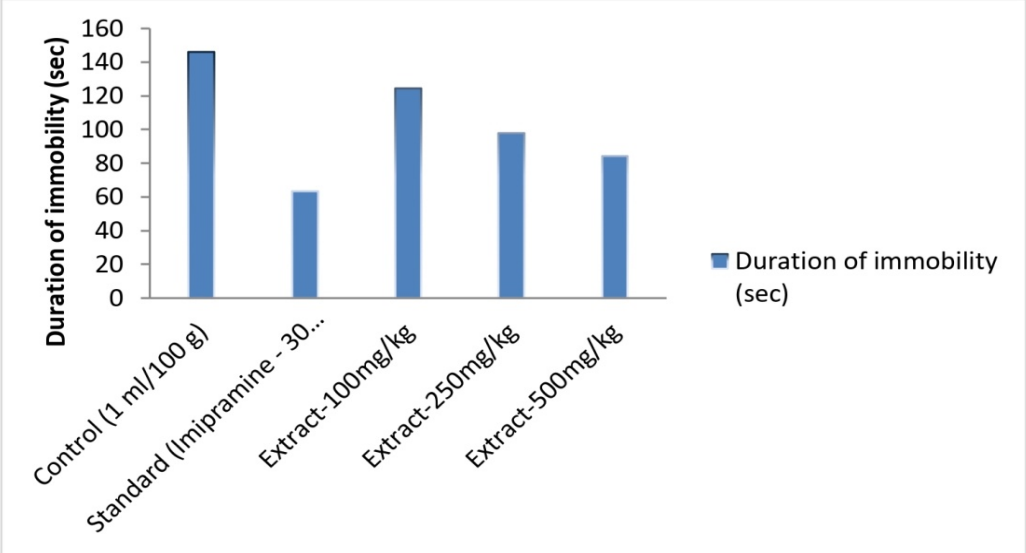
Tail Suspension Test (TST)

Similarly, in the Tail Suspension Test (TST), mice treated with SLE exhibited a dose-dependent decrease in immobility time compared to the control group. The control group displayed an average immobility time of 147.4±0.96 sec when administered saline. Conversely, the standard group treated with Imipramine demonstrated significantly reduced immobility, with an average time of 89.2±0.76 sec. Mice treated with SLE at doses of 100 mg/kg, 300 mg/kg and 500 mg/kg exhibited reduced immobility times of 128±1.61 sec, 117.4±0.96 sec and 104.4±0.63 sec, respectively. Similar to the FST results, there was a progressive reduction in immobility time with increasing doses of SLE and all doses

Table 1: Effect of *Sedum lineare* on Immobility Time in Forced Swim Test.

Group	Treatment	Duration of immobility (sec)
I	Control (1 mL/100 g)	146.2±1.14
II	Standard (Imipramine-30 mg/kg)	63.4±0.82**
II	Extract-100 mg/kg	124.6±1.32**
IV	Extract-250 mg/kg	98±0.72**
V	Extract-500 mg/kg	84.4±1.20**

Each value represents Mean±S.E.M, (n=5). **$P<0.05$ when compared with control using One way ANOVA followed by Dunett's *t*-test.



Graph 1: Effect of *Sedum lineare* on immobility time in Forced swim test.

showed statistical significance compared to the control group (p<0.05) shown in Table 2, Graph 2.

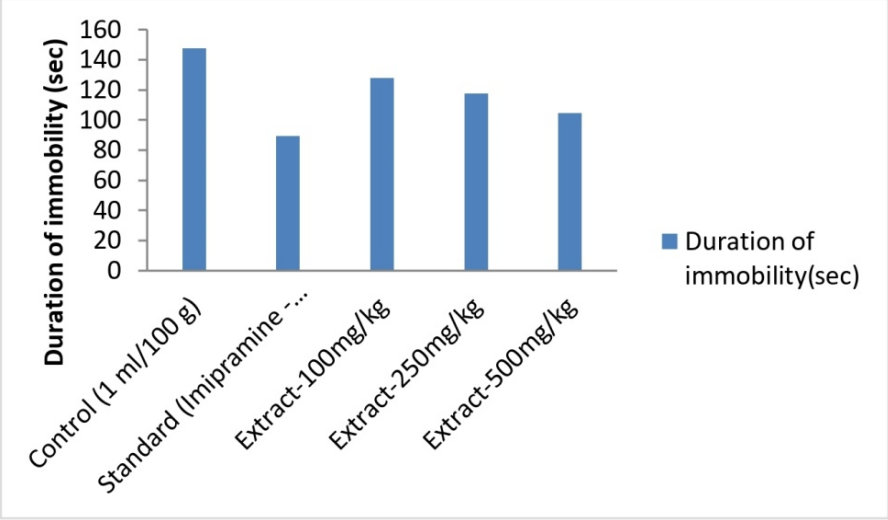
Models for Muscle relaxant study

Grip Strength

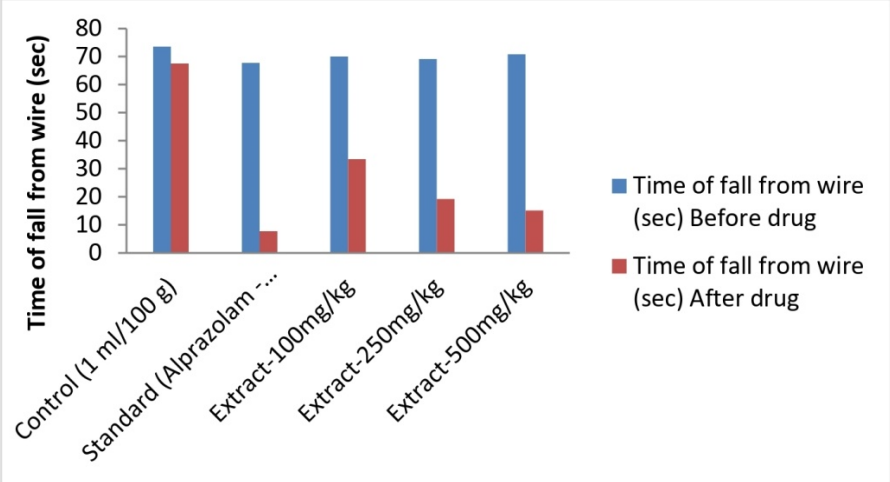
In the Grip Strength Test, mice were assessed for their ability to maintain grip on a wire before and after drug administration. The control group, receiving saline, showed a slight decrease in grip strength, with a time of fall from the wire increasing from 73.6±0.92 sec to 67.6±1.50 sec, indicating an 8.1% decrease in activity. Mice treated with the standard drug Alprazolam, exhibited a significant reduction in grip strength, with the time on the wire decreasing from 67.8±1.31 sec to 7.8±0.58 sec, indicating an 88.5% decrease in activity. Those treated with *Sedum lineare* Extract (SLE) showed dose-dependent reductions in grip strength. At doses of 100 mg/kg, 250 mg/kg and 500 mg/kg, mice exhibited reductions in activity by 52.2%, 72.2% and 78.5%, respectively, indicating significant muscle relaxant effects compared to the control group (p<0.05) shown in Table 3, Graph 3.

Inclined Plane

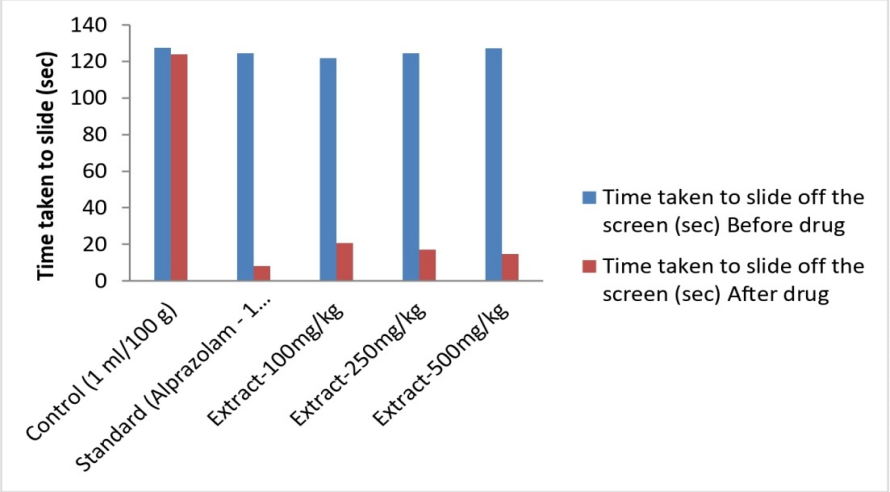
In the Inclined Plane Test, mice were assessed for the time taken to slide off before and after drug administration. The control group showed minimal changes in muscle relaxation, with the time taken to slide off the screen increasing from 127.6±0.92 sec to 124±0.70 sec, indicating a 2.8% decrease in activity. Mice treated with Alprazolam exhibited a substantial increase in muscle relaxation, with the time taken to slide off decreasing from 124.4±0.81 sec to 8.2±0.86 sec, indicating a remarkable 93.4% decrease in activity. Those treated with *Sedum lineare* Extract (SLE) demonstrated dose-dependent increases in muscle relaxation. At doses of 100 mg/kg, 250 mg/kg and 500 mg/kg, mice exhibited increases in



Graph 2: Effect of *Sedum lineare* on immobility time in Tail Suspension test.



Graph 3: Effect of *Sedum lineare* on Time spent in thread in Grip strength.



Graph 4: Effect of *Sedum lineare* on skeletal muscle relaxant activity by using inclined plane test in mice.

Table 2: Effect of *Sedum lineare* on Immobility Time in Tail Suspension Test.

Group	Treatment	Duration of immobility(sec)
I	Control (1 mL/100 g)	147.4±0.96
II	Standard (Imipramine-30 mg/kg)	89.2±0.76**
II	Extract-100 mg/kg	128±1.61**
IV	Extract-300 mg/kg	117.4±0.96**
V	Extract-500 mg/kg	104.4±0.63**

Each value represents Mean±S.E.M, (n=5). **p<0.05 when compared with control using One way ANOVA followed by Dunett's t-test.

Table 3: Effect of *Sedum lineare* on Time spent in thread in Grip strength.

Group	Treatment	Time of fall from wire (sec)		% Change in activity
		Before drug	After drug	
I	Control (1 mL/100 g)	73.6±0.92	67.6±1.50	8.1%
II	Standard (Alprazolam-1 mg/kg)	67.8±1.31	7.8±0.58	88.5%
II	Extract-100 mg/kg	70±1.64**	33.4±0.92**	52.2%
IV	Extract-250 mg/kg	69.2±1.06**	19.2±0.86**	72.2%
V	Extract-500 mg/kg	70.8±0.86**	15.2±0.86**	78.5%

Each value represents Mean±S.E.M, (n=5). **p<0.05 when compared with control using One way ANOVA followed by Dunett's t-test.

relaxation by 82.9%, 86.1% and 88.3%, respectively, indicating significant muscle relaxant effects compared to the standard drug (p<0.001) shown in Table 4, Graph 4.

DISCUSSION

In summary, the current research conducted behavioural assays of animal models to examine the antidepressant and muscle relaxant activities of the *Sedum lineare* extract. As a result, SLE significantly influenced the immobility time of both FST and TST, which is considered a potential treatment for antidepressants. Moreover, the results showed that SLE remarkably inhibited grip strength and the righting reflex in a dose-dependent pattern. FST and TST are two of the most common behavioural tests employed to investigate antidepressant-like action in mice. Imipramine, an approved standard drug for depression, significantly decreased the immobility time in both tests. This result validates the effectiveness of the methods employed in our study. Additionally, SLE significantly decreased the immobility time in a dosage-dependent manner, suggesting an antidepressant effect. Previous assessments of behavioural tests indicated that the antistress or predisposition of the plant extracts might underlie their antidepressant-like potential. Moreover, the mechanism through which SLE exerts antidepressant activity could be by regulating neurotransmitter concentration, neurogenesis or inhibition of HPA. More studies are needed to investigate the precise mechanism of SLE in exerting an antidepressant effect.

Table 4: Effect of *Sedum lineare* on skeletal muscle relaxant activity by using inclined plane test in mice.

Group	Treatment	Time taken to slide off the screen (sec)		% Change in activity
		Before drug	After drug	
I	Control (1 mL/100 g)	127.6±0.92	124±0.70	2.8%
II	Standard (Alprazolam-1 mg/kg)	124.4±0.81	8.2±0.86	93.4%
II	Extract-100 mg/kg	121.8±1.06**	20.8±1.24**	82.9%
IV	Extract-250 mg/kg	124.6±1.07**	17.2±0.58**	86.1%
V	Extract-500 mg/kg	127.2±1.24**	14.8±1.06**	88.3%

Each value represents Mean±S.E.M, (n=5). **p<0.05 when compared with control using One way ANOVA followed by Dunett's t-test.

The muscle relaxant activity was determined from the results of muscles strength from the grip strength test and the duration from the inclined plane test. In this study, a dose-dependent decrease in muscles power and the duration of sliding off the plane was observed. The muscle relaxant activity could, therefore, be due to the modulation of neuromuscular transmission, calcium ion influx or the action of muscle contractility by SLE. Therefore, observed are evidence of muscle relaxant effect on SLE which could have some benefits. The benefits could be in the management of conditions such as abnormal muscle spasms or stiffness. Studies to discover the exact mechanism of muscle relaxant should be done to ascertain the exact benefit.

CONCLUSION

In conclusion, the findings of the present research suggest that the extract of *Sedum lineare* possesses both antidepressant and muscle relaxant properties. These findings are supported by the extraordinary impact that the extract has on the behaviour of rats. The findings presented here point to a novel application of *Sedum lineare* in clinical settings for the treatment of depressive disorders and illnesses connected to the muscles. However, in the future, the molecular activity and safety of SLE will need to be taken into consideration in order to demonstrate the safe and effective antidepressant and muscle relaxant effects for human use.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

ANOVA: Analysis of Variance; **CPCSEA:** Committee for the Purpose of Control and Supervision of Experiments on Animals; **SLE:** *Sedum lineare* extract; **FST:** Forced Swim Test; **HPA:** Hypothalamic-Pituitary-Adrenal; **SEM:** Standard Error of Mean; **TST:** Tail Suspension Test.

ETHICAL APPROVAL

This research adhered to the ethical guidelines for the use of animal subjects. Animal welfare considerations were taken into account, minimising pain, distress and suffering. Ethical approval was obtained from the Institute of Pharmacy, Bundelkhand University, Jhansi (Approval number: 716/GO/Re/S/02/CPCSEA) for animal research.

SUMMARY

Behavioural assays on animal models have been used to assess the antidepressant and muscle relaxant effects of *Sedum lineare* extract. The study has shown that SLE significantly reduces the immobility time in FST and TST, indicating that it has an antidepressant effect. However, SLE had dose-dependent effects on muscle relaxation due to the inhibition of grip suppress and righting reflect. These results suggest that SLE mainly acts by modulating neuromuscular or muscle contractility. The sedative effects reduce muscle spasm or stiffness by causing the muscle to relax. Therefore, SLE has a muscle relaxant activity due to the aforementioned effects. However, the results do not show the exact mechanism by which SLE might be achieving these effects. Thus, future work can focus on the molecular mechanisms of SLE and the toxicity affected by SLE.References

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