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RESEARCH ARTICLE

Neuroprotective Potential of *Solanum giganteum* Leaves Extracts against Neurotoxin Agents and Oxidative DNA Damage in Rodents

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Abstract

Other species of Solanum are evaluated as neuroprotective and have conventionally been applied for the management of CNS disorders; on the other hand, investigational data to support this practice is lacking. Therefore, we aimed to assess the effect of *Solanum giganteum* leaves extracts aligned with Aluminium chloride-induced memory loss of Alzheimer's Disease (AD) type within the rats. The work was considered to persuade dementia by chronic administration of aluminium chloride by a dose of 175 mg/kg, p.o. designed for 28 days in rats and rats are separated keen on seven groups, i.e. normal, negative control, standard groups as well as four groups of *Solanum giganteum* Jacq. (chloroform extract (SGC100 and 200 mg/kg) and alcoholic extract (SGA 250 and 500 mg/kg) p.o.), whereas these groups were treated and examined till the 28th day of an investigational trial. The research's behavioral, neural, and biochemical characteristics were set up during or after it. DNA fragmentation and histological changes in the brain were also noted. Aluminium chloride on a dose of 175 mg/kg, p. o. had extensively persuaded dementia and *Solanum giganteum* Jacq. leaves chloroform extract 200 mg/kg p.o., overcomes therapeutic outcome against Aluminium chloride persuaded dementia of AD category in rats. *Solanum giganteum* Jacq. of chloroform extract makes use of neuroprotective action against $AlCl_3$-induced behavioral considerations such as cognitive deficit and locomotor destruction. Further, *Solanum giganteum* Jacq. of chloroform extract was also able to cure oxidative stress and neuroinflammation in the hippocampus and cortical areas, reversing the biochemical abnormalities caused by aluminum.

Keywords: $AlCl^3$, Alzheimer's, SGA, SGC, *Solanum giganteum*

1. Introduction

The progressive loss of a neuron's configuration or function is referred to as neurodegeneration[1]. Because neurons typically cannot multiply or repair themselves, the body is unable to repair damaged or dead neurons[2]. Numerous neurodegenerative illnesses have multiple underlying causes, along with genetic mutation, protein misfolding, protein degradation pathways, membrane damage, and mitochondrial dysfunction[1]. The neurodegeneration process leads to neurodegenerative disorders such as Amyotrophic Lateral Sclerosis (ALS), Parkinson's disease, Alzheimer's disease, and Huntington's Disease (HD)[1-3]. It has been proposed that Alzheimer's disease is a protein-misfolding disorder characterized by the loss of neurons and synapses in the cerebral cortex and some subcortical regions. This disorder is thought to be brought on by an accumulation of abnormally folded A-beta and tau proteins in the brain[1-4]. In the United States, there are 5.4 million people who have Alzheimer's Disease (AD), and during the next 20 years, it is anticipated that this number will significantly rise[5-7]. Approximately 34 million individuals worldwide currently suffer from Alzheimer's

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disease, and lifestyle variables that may be changed, like obesity and inactivity, are linked to a higher chance of developing the illness[8]. Neither medication nor a cure for Alzheimer's disease exists that can halt or reverse the illness's course[4].

Neurodegenerative illnesses cannot be treated with drugs, but one of the world's oldest medical systems, Ayurveda does. Alzheimer's disease is a vata, pitta, and kapha imbalance, according to Ayurveda. Treatment of cognitive deficits has shown to be greatly aided by a herbal medical approach. It has been studied how the plant-like *Bacopa monniera, Rosmarinus officinalis, Curcuma longa, Celastrus paniculatus,* and *Glycyrrhiza glabra* affect the brain's cognitive function. These plants are a strategy for dementia and Alzheimer's disease prevention and therapy[8-10].

The leaves and fruits of *Solanum giganteum* (SG), a renowned medicinal plant, have historically been applied on festering, open sores as a dressing. Plentiful in tropical Africa, India and practically every other region of the world (Maharashtra; Gujarat; Punjab and Rajasthan). For the treatment of neurological illnesses, a variety of Solanum species, including *S. lyratum, S. xanthocarpum, S. khasianum, S. nigrum, S. gracile, S. tuberosum* and *S. laciniatum* are widely utilised. Numerous pharmacological actions, including antibacterial, anti-inflammatory and antinociceptive, anti-cancer and neuroprotective ones, are produced by the solasodine alkaloid that is derived from plants of the solanum genus[11-16].

A herb to enlighten the brain was researched utilizing different models, Alzheimer's illness and Aluminum-induced neurotoxicity[16]. Aluminium promotes the buildup of insoluble amyloid protein and the formation of neurofibrillary tangles (NFTs), which disrupt cholinergic transmission by causing neuronal degeneration. This impairs the ability to acquire and remember new information[17,18]. Using the $AlCl_3$-induced neurotoxicity paradigm neurotoxicity model, every behavior assessment, including locomotor activity, T-maze, and Morris water maze, was carried out for *Solanum giganteum* extracts. It also involves biochemical evaluations including protein estimation, lipid peroxidation, and AchE level. Using extracts from *Solanum giganteum* (Family: Solanaceae), an *in vivo* antioxidant investigation was conducted. Histopathology and additional research on the impact of medicinal plants on the DNA fragmentation of brain cells are needed to comprehend other alterations in the brain following therapy. DNA fragmentation was inhibited, which suggests that the extract is protecting the brain at the molecular level[18,19].

2. Material and Method

All chemicals utilizes were of analytical grade.

2.1 Extraction

Solanum giganteum Jacq. freshly collected leaves were dried for three weeks at room temperature. The dried plant material was ground into a coarse powder and weighed. At a temperature range of 40–80 °C, petroleum ether, chloroform, and ethanol were used in a Soxhlet apparatus for the hot extraction. Before and after each extraction, the marc was fully dried and weighed. The extract was concentrated at room temperature by the evaporation of solvent[20,21].

2.2 Experimental Animals

Wistar strain albino rats of either sex, weighing in at 150-200 g, were used in the experiment. The animals were cared for according to CPCSEA's standards. The experimental methodology was carried out per the CPCSEA criteria for laboratory animal facilities after receiving approval from the institutional animal ethics committee of Satara College of Pharmacy, Satara. SCOP/IAEC/102/2020 (CPCSEA registration number: 1314/PO/Re/S/2009/CPCSEA) is the protocol approval number.

2.3 Aluminium Chloride-Induced Neurotoxicity

Wistar rats were selected at random, tagged to facilitate character recognition, and kept in their cages for at least 7 days before the experiment to allow acclimation to the lab settings. Wistar rats of either sex between weight ranges of 150-200 gm were chosen.

Individual identification tags were attached to randomly selected Wistar rats of either sex, weighing between 150 and 200 gm, and they were kept in their cages for at least 7 days before the experiment so they could get acquainted with the lab setting.

Seven groups of six individuals each were created from the animals. Group, I administered normal saline as the control group. Group II (Negative control) administered 175 mg/kg of $AlCl_3$ orally. $AlCl_3$175 mg/kg p.o. and the normal medication piracetam 250 mg/kg p.o. were administered to Group III (Standard Control

STD). $AlCl_3$ 175 mg/kg p.o. and SG-Chloro (SGC) extract 100 and 200 mg/kg p.o. were given to Group IV. $AlCl_3$ 175 mg/kg p.o. and SG-Alcohol (SGA) extract 250 and 500 mg/kg p.o. were given to Groups VI and VII. One hour after the usual therapy, as stated above, from the first day to the 28th day. After three hours of therapy, the animals were evaluated for a variety of physical and behavioral parameters on days 7, 14, 21, and 28. They were sacrificed while under anaesthesia after the final dose was administered after 24 hours. The brain was cleaned, removed, and used for various biochemical analyses after being washed with phosphate-buffered saline (pH 7.4)[22-24].

2.4 Behavior Assessment

Rats were given a one-week training program to get them ready for behavioral research. Rats received nothing except food and water during the training period. Rats with complete training were preferred for behavior research. Locomotor activity, rotarod activity, elevated plus maze activity, T maze activity, and Morris water maze activity were all carried out during a weak time of the behavior study[25-28].

2.5 Biochemical Parameter

Preparation of homogenate: Immediately following behavioral evaluation, animals were decapitated and sacrificed for the biochemical investigation. There was a brain removal. 0.1 M phosphate buffer was used to prepare 10% (w/v) tissue homogenate (pH 7.4). The integrated was spun by 10,000 g for 15 minutes to separate the clear floatable, which was then utilised to quantify the biochemical parameters.

2.5.1 Acetylcholinesterase (AChE) Activity

Using Ellman's approach, acetylcholinesterase was quantitatively estimated. The augment in yellow colour that resulted from the effect of thiocholine with 5, 5'-dithiobis-(2-nitrobenzoic acid) [DTNB] was used to calculate the enzyme activity[29].

2.5.2 Quantity of the Endogenous Antioxidant Resistance System

To estimate the levels of lipid peroxidation[30], catalase activity[31], superoxide dismutase activity[32], and glutathione activity[33] in the brain integrated was employed.

2.6 Necropsy

Once the protocol was accomplished, the animals were anaesthetized, and a necropsy was taken out on a few randomly picked animals of each group and per sex to look at the macroscopic exterior features of the brain. Organs were collected, stored in 10% buffered formalin, and then embedded in paraffin. Hematoxylin-stained histology sections (5 m thick) were analyzed under a light microscope[34].

2.7 DNA Isolation from Brain Tissue

The DNA extraction kit from BioEra was used to separate DNA from tissue samples. Each group's samples were filled independently on a 1% agarose gel including 0.5 mg/ml ethidium bromide after being independently combined with 20 µl of DNA samples and 5 µl of DNA loading dye. The sequence DNA ladder (0.5 mg per well), normal group, Negative control group, STD group, SGC (100 and 200 mg/kg), and SGA (250 and 500 mg/kg), respectively, were loaded with DNA samples from each group on an agarose gel. A 50 V current is used for gel electrophoresis. The gel was photographed with the digital camera and evaluated with a UV transilluminator and gel doc system. Orange bands served as confirmation that DNA was present[35].

2.8 Statistical Analysis

The statistics were articulated as Mean ± SEM. In all the tests, the measure for statistical significance was set at $p < 0.05$. The statistics for all studies were examined with one-way ANOVA pursued by Tukey-Kramer Multiple Comparisons Test.

3. Results

3.1 Body Weight Changes

To evaluate the animals' overall health, body weights were taken every 7 days. Rats who were given $AlCl_3$ for 28 days experienced significantly lower body weights than the rats in the normal control group (Table 1). After 14 days, body weight significantly decreases in all groups but the typical control group. As evaluated in the negative control group, those who received Piracetam, SGC, and SCA extract along with $AlCl_3$ had a considerable rise in body weight.

Table 1. Effect of SGC and SGA extracts on body weight in $AlCl_3$administered rats. Data are mean ±SEM values (n = 6 in each group). Data were analyzed by One way ANOVA followed by Tukey-Kramer Multiple Comparisons test. *P < 0.05, **P < 0.01, ***P < 0.001, a - compared with normal control, b - Compared with Negative control group

Group	Days			
	7	14	21	28
Normal	168.75±0.33	178.33±0.33	196.17±0.30	215.33 ±0.21
Negative Control	170.50±0.34	172.00±0.77	165.67±0.33***a	155.17±0.60***a
STD	174.67±0.61	172.50±0.42	180.33±0.33***b	182.00±0.36***b
SGC 100 mg/kg	172.83±0.30	167.83±0.65	169.17±0.47	174.33±0.33***b
SGC 200 mg/kg	170.50±0.42	167.83±0.47	177.50±0.42**b	185.33±0.33***b
SGA 250 mg/kg	165.83±0.47	160.33±0.49	172.17±0.54*b	165.67±0.42*b
SGA 500 mg/kg	173.50±0.42	170.00±0.25	182.33±0.61***b	180.00±51***b

3.2 Locomotors Activity

According to the observations made on the various experimental rat groups, continuous administration of $AlCl_3$ caused changes in the animals' behavior patterns (Table 2 (A)), which revealed a significantly lesser level of locomotor activity in the negative control group than in the normal control group. As compared to the negative control group, those who received Piracetam (STD), SGC 100, 200, and SGA 200 mg/kg in combination with $AlCl_3$ experienced a significantly higher level of locomotor activity. In the assessment of the negative control group, SGA 250 mg/kg in combination with $AlCl_3$ generated a less substantial increase in locomotor activity.

3.3 Rotarod Activity

Rats in the negative control group showed a significant decline in the fall of time (s) on the rotarod when evaluated to the normal group, whereas rats in the groups treated with piracetam (STD), SGC, and SGA combined with $AlCl_3$ illustrated a significant increase in the fall of time (s) on the rotarod when compared to the negative control group (Table 2 (B)).

3.4 T Maze

While groups treated with Piracetam, SGC 100 and 200 mg/kg also SGA 500 mg/kg in combination with $AlCl_3$ induced significant decreases in the time (s) by the rat to reach the food in the T maze behavior stress test in assessment with the negative control group, T maze activity showed significant increases in the time (s) taken by the rat to achieve the food in the T maze behavior stress test for the negative control group while evaluated to the normal group (Table 2 (C)).

3.5 Elevated Plus-Maze

Whereas the groups treated with Piracetam, SGC 200 mg/kg combination with $AlCl_3$ induced a significantly increased in the time (s) in use by the rat to travel in the open arm in comparison with the negative control group, elevated plus-maze activity showed a significant decrease at the moment in time (s) taken by the rat to move in the open arm for the negative control group while match up to the normal group and treated groups. As opposed to the negative control group, groups treated with SGC 100 mg/kg and SGA at both doses did not significantly lengthen the time (s) required for the rat to travel in the open arm (Table 2 (D)).

3.5 Morris Water Maze

Morris water maze activity revealed that the time (s) it took a rat to reach a hidden platform improved significantly for the negative control group when match up to the normal group and treated groups, whereas groups treated with piracetam (STD), SGC 100 and 200 mg/kg along with SGA 500 mg/kg in along with $AlCl_3$ experienced significant decreases in that time (s) while match up to the negative control group (Table 2 (E)). The time (s) it took the rat to reach the hidden platform after being given SGA 250 mg/kg combined with $AlCl_3$ was not substantially shorter than it was for the negative control group.

3.6 Outcome of *Solanum giganteum* Extracts on Biochemical Factors

Rats treated with $AlCl_3$ had significantly elevated levels of the enzyme acetylcholine esterase than normal control groups and extract-treated groups; whereas rats treated with Piracetam (STD), SGC 200 mg/kg along with SGA 500 mg/kg along with $AlCl_3$ had significantly lesser levels of the enzyme acetylcholine esterase than the negative control group (Figure 1 (A)). However, when combined with $AlCl_3$, groups treated with SGC 100 mg/kg as well as SGA 250 mg/kg did not significantly lower the rat's level of the acetylcholine esterase enzyme match up to the negative control group. A considerable drop within the level of the AchE enzyme in the brain homogenate demonstrated a significant improvement in the AD state with SGC 200 mg/kg.

Treatment of rats with $AlCl_3$ had a considerably higher MDA level in their brains matched up to the normal control group, but rats treated with piracetam (STD) as well as SGC 200 mg/kg combined with $AlCl_3$ had a significantly lower MDA level in their brains match up to the negative control group. However, when combined with $AlCl_3$, the groups treated with SGC 100 mg/kg as well as SGA 250 mg/kg did not significantly lower the rat's MDA levels when match up to the control group (Figure 1 (B)). The rat brain MDA levels decreased substantially, representing that piracetam and SGC 200 mg/kg significantly enhanced AD status.

Table 2. Effect of SGC and SGA extracts on locomotor activity, rotarod activity, T maze activity, elevated plus maze activity and Morris water maze activity in $AlCl_3$ administered rats. Data are mean ± SEM values (n = 6 in each group). Data were analyzed by One way ANOVA followed by Tukey-Kramer Multiple Comparisons test. *p < 0.05, ** p < 0.01, *** p < 0.001, a - compared with normal control, b - Compared with Negative control group

(A)

Groups	Locomotor activity /10min			
	7	14	21	28
Normal	186.3±6.525	180.00 ± 6.83	175.8 ± 7.23	189.3 ± 6.13
Negative	78.5±3.78***a	27.83±5.40***a	37.5±4.23***a	32.34 ±3.23***a
STD	161.2±5.974**a ***b	187.50±6.55***b	119.5±6.67**a ***b	115.2 ±6.35 ***a ***b
SGC 100 mg/kg	98.7 ±7.149**a ***b	89.80 ± 5.38***a ***b	75.3 ± 4.37***a ***b	80.6 ± 3.37 ***a***b
SGC 200 mg/kg	140.8 ±7.35***a ***b	145.30±5.78***a ***b	136.3±3.91***a ***b	104.6 ± 6.91 ***a***b
SGA 250 mg/kg	95.7 ±3.073***a ***b	84.30 ± 5.00***a ***b	66.5 ± 3.87***a ***b	48.5 ± 4.87***a *b
SGA 500 mg/kg	117.3 ±7.710***a ***b	109.20 ± 4.79***a***b	99.5 ± 5.54***a ***b	86.6 ± 6.54 ***a***b

(B)

Groups	Rotarod activity /5 min			
	7	14	21	28
Normal	230.8± 5.83	227.50 ± 6.55	212.50 ±7.15	212.50 ± 5.15
Negative	140.0 ± 5.62***a	70.00 ± 3.68***a	44.83 ±6.88***a	36.5 ± 4.78 ***a
STD	176.7 ± 4.41***b	170.80 ± 3.51***b	165.50 ±4.72***a ***b	141.25 ± 4.72 ***a***b
SGC 100 mg/kg	152.5 ± 3.81***a	96.70±4.41***a ***b	83.30±3.33***a***b	63.30 ±5.33***a***b
SGC 200 mg/kg	166.7 ± 3.53**a **b	150.00 ± 5.32**a ***b	127.80 ±2.24**a ***b	111.78 ± 3.52 ***a ***b
SGA 250 mg/kg	142.5 ± 3.61***a	102.80 ± 3.21***a***b	72.30 ±4.63***a***b	59.30 ±2.36***a***b
SGA 500 mg/kg	160.8 ± 3.00***a**b	132.10 ± 2.86***a***b	113.20±3.60***a***b	71.54 ±1.62 ***a ***b

(C)

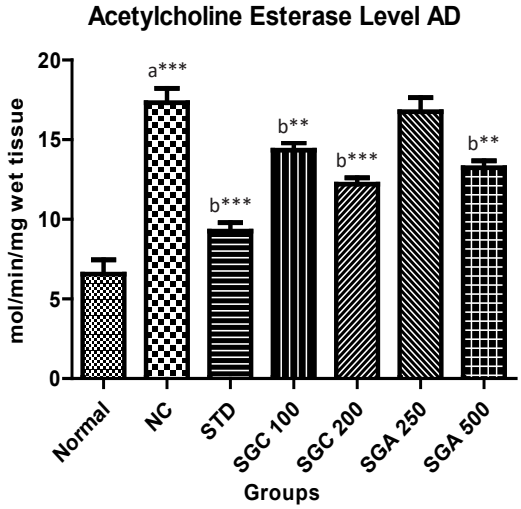
Groups	Time required to find are ward (Sec.)			
	7	14	21	28
Normaʟ	70.67 ±4.01	72.00 ±2.30	72.17 ±3.06	68.47 ±4.16
Negative	129.20 ±2.71***a	149.20 ±1.97***a	157.50 ±3.09***a	166.50 ±3.09***a
STD	91.30 ±7.60 *a ***b	94.70 ±4.10 *a ***b	90.83 ±2.70*a ***b	102.83 ±3.70*a ***b
SGC 100 mg/kg	114.20 ±4.36***a *b	134.20 ±2.38***a *b	139.80 ±2.77***a *b	138.60 ±3.17***a **b
SGC 200 mg/kg	105.30 ±2.90*a ***b	114.50 ±2.93*a***b	112.30 ±4.63*a ***b	115.30 ±3.10*a ***b
SGA 250 mg/kg	125.80 ±3.74*a	133.80 ±3.60*a	143.67 ±3.30*a *b	153.67 ±4.70*a
SGA 500 mg/kg	113.67 ±3.50*a *b	121.70 ±4.36*a **b	125.30 ±3.00*a ***b	128.60 ±4.10*a ***b

(D)

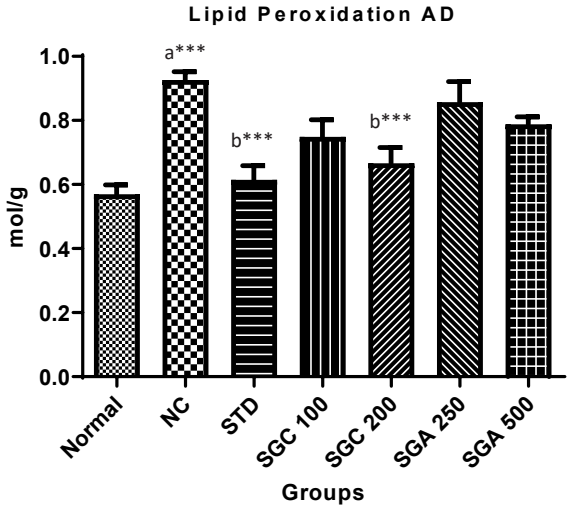
Groups	Transfer of latency(sec)			
	7	14	21	28
Normal	115.00±3.65	113.20 ±3.96	108.00 ±5.30	102.10 ±6.30
Negative	92.50 ± 2.14*a	39.17 ± 1.64*a	26.50 ±1.20*a	14.30 ± 3.20*a
STD	101.80±5.58	75.17 ± 2.71***a *b	59.33± 3.07***a *b	59.33± 4.77***a ***b
SGC 100 mg/kg	90.00±1.88 *a	40.17±3.51*a	32.67±1.66*a	28.85 ± 3.65***a *b
SGC 200 mg/kg	97.67±7.00*a	60.83±1.30***a *b	46.50±2.81***a *b	38.50 ± 3.81***a *b
SGA 250 mg/kg	93.17±3.91*a	43.50±2.14*a	29.17±1.51*a	21.65 ± 4.62*a
SGA 500 mg/kg	92.00±1.98*a	46.83 ±3.00*a	38.33 ±3.53*a	29.50 ± 2.64***a *b

(E)

Group	Mean latency to reach a platform(sec)			
	7	14	21	28
Normal	36.33 ± 2.10	33.00±2.88	29.83 ± 4.36	25.63 ± 5.26
Negative	53.20 ±3.51***a	64.20 ±2.00***a	72.20 ±2.38***a	74.20 ±3.28***a
STD	48.50±2.43*a	53.17±3.51***a *b	41.83±2.38*a ***b	39.83±1.68*a ***b
SGC 100 mg/kg	51.83±4.36***a	61.67±1.66***a	59.17±1.53***a **b	52.17±2.83***a ***b
SGC 200 mg/kg	46.00 ±4.35**a	54.60±1.93**a	47.50±1.89**a ***b	37.50±1.75*a ***b
SGA 250 mg/kg	58.33±2.26***a	66.50±1.66***a	59.80±2.81***a	69.30±3.61***a
SGA 500 mg/kg	52.33±2.45***a	63.17±1.93***a	54.38±2.38***a **b	57.17±1.65***a **b



(A)



(B)

Figure 1. Effect of *Solanum giganteum* extracts on AchE level and lipid peroxidation level. Data are mean ±SEM values (n = 6 in each group). Data were analyzed by One way ANOVA followed by Tukey-Kramer Multiple Comparisons test. *P < 0.05, **P < 0.01, ***P < 0.001, (a) compared with normal control, (b) Compared withNegative control group.

3.7 Effect of *Solanum giganteum* Extracts on Sod Level, Catalase Level and Glutathione Level

Treatment of rats with $AlCl_3$ had a substantial decrease in brain SOD levels while matching up to the normal control group, whereas rats applied to treat piracetam (STD) had a significant rise in brain SOD levels while matching up to the negative control group (Figure 2 (A)). On the other hand, as matched up to the negative control group, the groups treated with SGC 100 mg/kg, SGA 250 mg/kg, and SGA 500 mg/kg along with $AlCl_3$ did not extensively lower the level of brain SOD in the rats. A much higher level of brain SOD in the treated rats with SGC 200 mg/kg plus piracetam showed a considerable improvement in their AD condition.

Catalase levels in the brain showed a significant decline in rats treated with $AlCl_3$ as a match to among the normal control group, whereas groups treated with piracetam

(STD) and SGC 200 mg/kg in combination with $AlCl_3$ induced a considerable extent in brain catalase level of rats into comparison with the negative control group (Figure 2 (B)). Whereas groups treated with SGC 100 mg/kg and SGA 250 and 500 mg/kg in combination with $AlCl_3$ induced does not significantly decrease brain catalase levels in the rat in comparison with the negative control group. SGC 200 mg/kg and piracetam treated exhibited a significant enhancement in the AD status as evidenced by a significantly increased brain catalase level within the rat.

Rats provided $AlCl_3$ treatment exhibited brain amounts of glutathione substantially lower than the normal control group, whereas rats treated with piracetam (STD) along with SGC 200 mg/kg in addition to $AlCl_3$ had significantly elevated amounts of glutathione in their brains matched up to the negative control group (Figure 2 (C)). However, when combined with $AlCl_3$, groups treated with SGC 100 mg/kg, SGA 250 mg/kg as well as SGA 500 mg/kg did not considerably lower the amounts of brain glutathione within the rats compared to the negative control group. The rat's brain Glutathione level considerably rose after treatment with piracetam and SGC 200 mg/kg, demonstrating a considerable improvement in the rat's AD state.

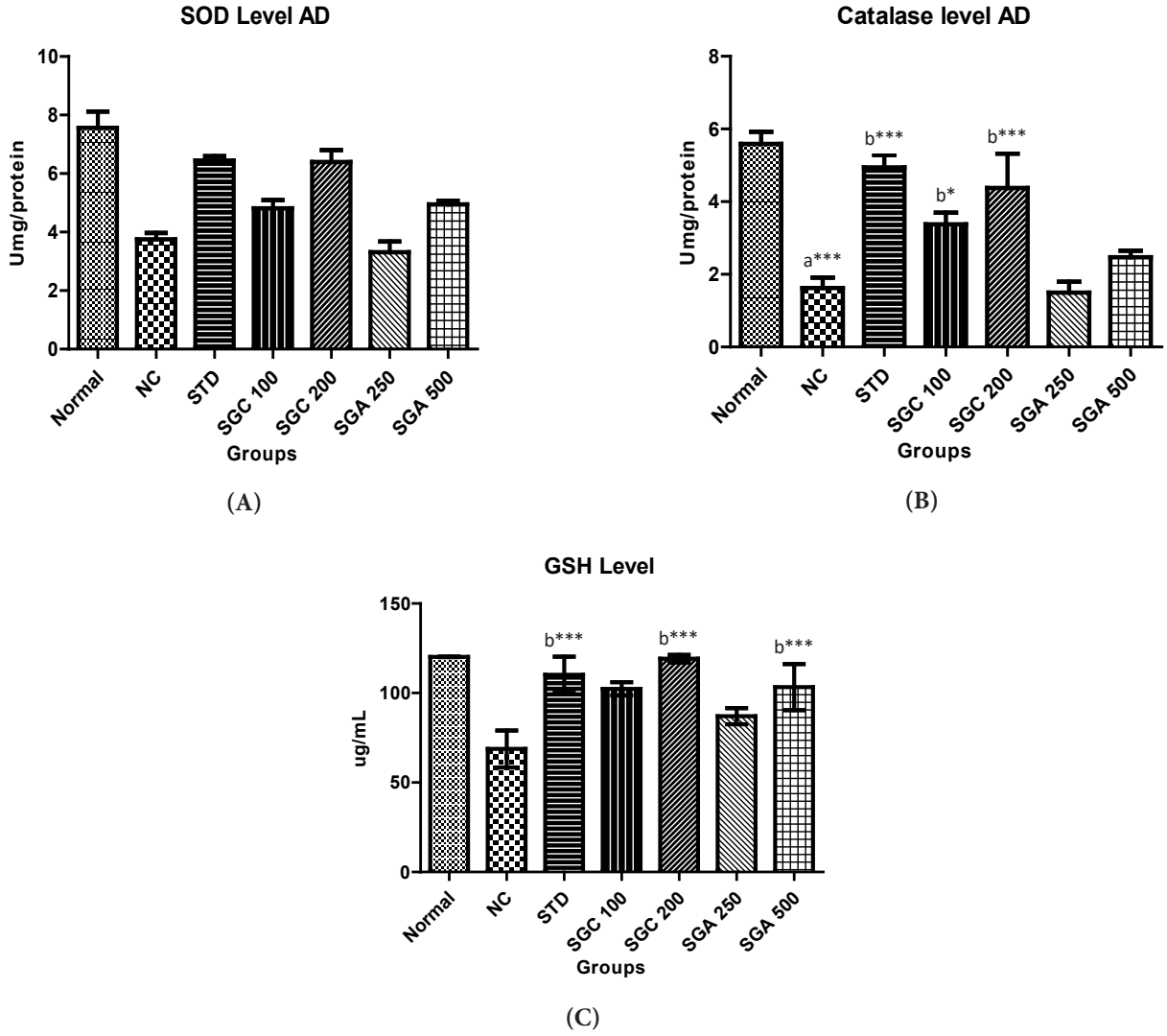


Figure 2. **(A), (B), (C)** Effect of SGC and SGA extracts on SOD, Catalase and Glutathione level in $AlCl_3$ administered Rats. Data are mean ±SEM values (n = 6 in each group). Data were analyzed by One way ANOVA followed by Tukey-Kramer Multiple Comparisons test. *P < 0.05, **P < 0.01, ***P < 0.001, a - compared with normal control, b - Compared with Negative control group.

3.8 Effect of *Solanum giganteum* Extracts on Cholesterol Level, and Protein Level

Cholesterol levels in the brain showed a significant decrease within rats treated with $AlCl_3$as match up to with the normal control group, whereas groups treated with piracetam (STD) and SGC 200 mg/kg in combinationwith$AlCl_3$induceda significant raise in brain Cholesterol level of rats in comparison with the negative control group (Figure 3 (A)). Whereas groups treated with SGC 100 mg/kg and SGA 250 and 500 mg/kg in combination with $AlCl_3$ induced no significant decrease in brain Cholesterol levels in the rat in comparison with the negative control group. SGC 200 mg/kg and piracetam treated exhibited a significant enhancement in the AD status as evidenced by a significantly increased brain cholesterol level in the rat.

Treatment of rats with $AlCl_3$ had a substantially lower protein level in their brains when match up to the normal control group, but rats treated with piracetam, SGC along with SGA in conjunction with $AlCl_3$ had a significantly higher protein level in their brains when match up to the negative control group (Figure 3 (B)). A considerable raise in the rat's brain protein level subsequent management with a prominent dose of SGC, SGA, and piracetam showed a significant improvement in the rat's AD condition.

3.9 Histopathology Study

Effect of *Solanum giganteum* extracts on rat models of Alzheimer's disease produced by $AlCl_3$ and brain histopathology (Figure 4). (A) The transverse section was observed to be intact in the healthy control group. No neuronal loss occurred in reverse. (B) In the aluminium, chloride treated negative control group, severe histological alterations such as neurodegeneration, inflammation, and vacuolated cytoplasm were seen. (C) and (E) The STD and SGC 200 mg/kg in the aluminum-treated group showed noteworthy improvement. (D), (F), and (G) additionally, the SGC 100 mg/kg and SGA 250 and 500 mg/kg in the aluminium chloride treated group did not exhibit remarkable improvement. Hematoxylin and eosin were used to stain the tissues at a magnification of about 100.

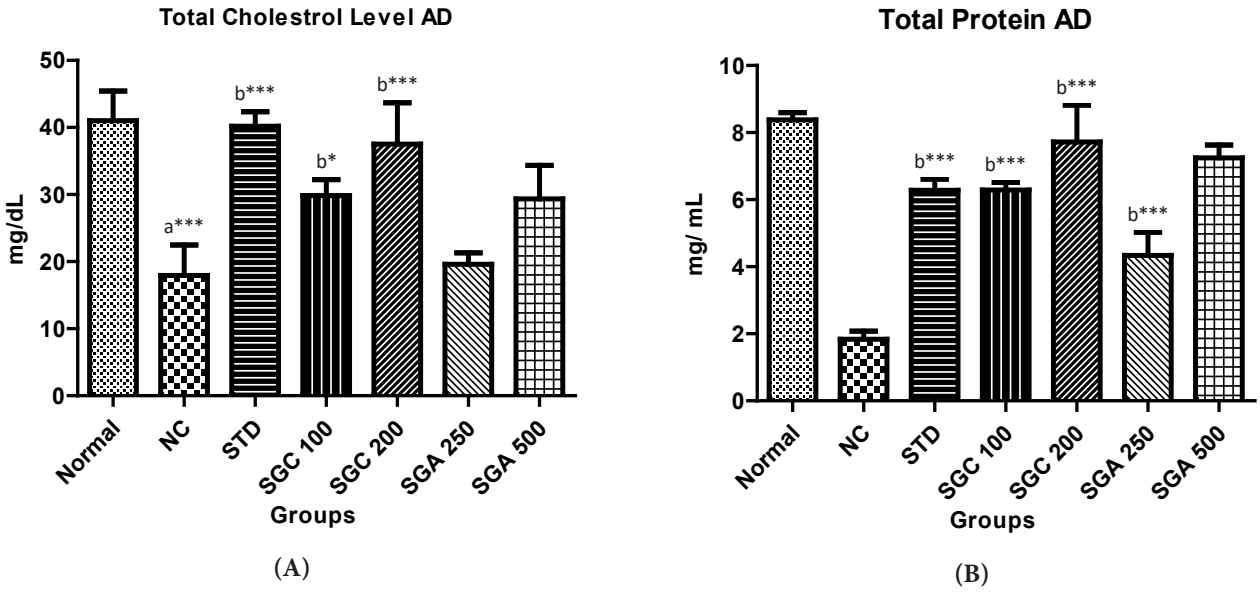
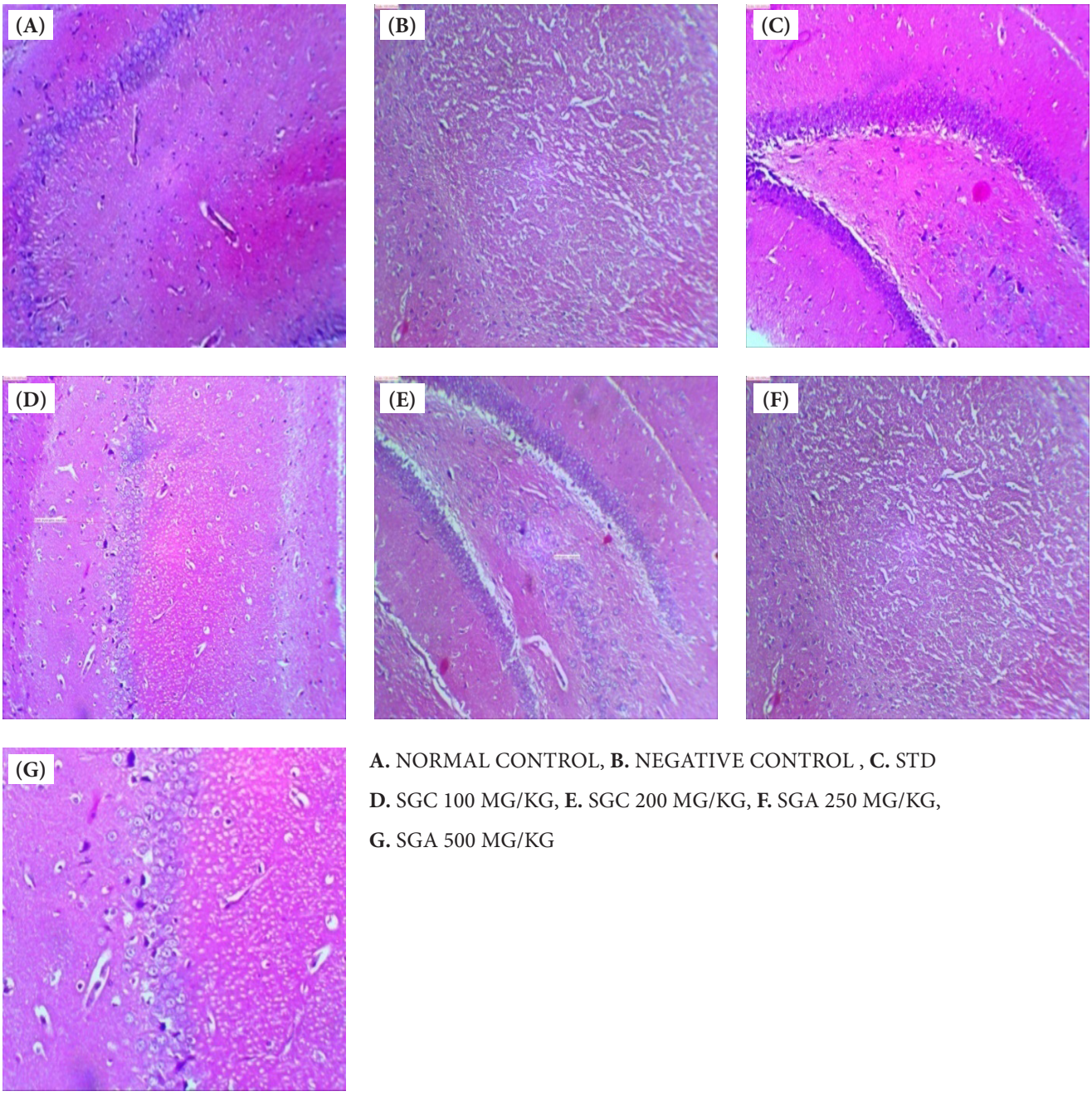


Figure 3. Effect of SGC and SGA extracts on cholesterol and protein level in $AlCl_3$ administered Rats. Data are mean ±SEM values (n = 6 in each group). Data were analyzed by One way ANOVA followed by Tukey-Kramer Multiple Comparisons test. *P < 0.05, **P < 0.01, ***P < 0.001, **(a)** - compared with normal control, **(b)** - Compared with Negative control group.



A. NORMAL CONTROL, **B.** NEGATIVE CONTROL , **C.** STD
D. SGC 100 MG/KG, **E.** SGC 200 MG/KG, **F.** SGA 250 MG/KG,
G. SGA 500 MG/KG

Figure 4. Histological sections of the rat brain for Alcl$_3$ induced neurotoxicity model.

3.9 DNA Study in $AlCl_3$ Model

A marker DNA split ladder was visible in Lane 1. Lane 2 exhibits a single intact band of the normal group. While Lane 3 is a group that was exposed to a toxicant ($AlCl_3$) and displayed DNA breakage in agarose gel electrophoresis. Lane 4 demonstrates that groups receiving standard care were able to fend against $AlCl_3$'s adverse effects. Lanes 5 and 6 demonstrate that SGC treatment at the tested doses (100 mg/kg and 200 mg/kg, respectively) was able to protect against the harmful effects of $AlCl_3$ and prevent DNA fragmentation. DNA fragmentation was seen in the SGC 100 mg/kg treated group's agarose gel electrophoresis. Lanes 7 and 8 demonstrate that the SGA-treated groups were incapable of protecting against the harmful effects of $AlCl_3$ on brain DNA damage at the tested doses examined (250 mg/kg and 500 mg/kg doses, respectively) (Figure 5).

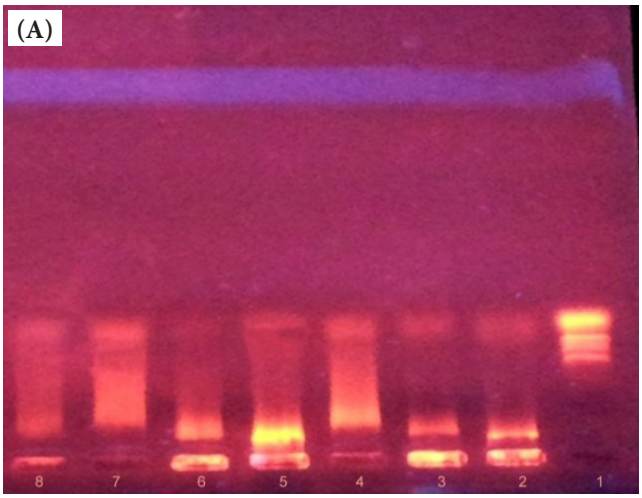


Figure 5. Agarose gel electrophoresis showing lanes of various treated groups ($AlCl_3$ model)

L_1: Marker DNA, L_2: Normal control grou p, L_3: Standard Group, L_4: Negative control group, L_5: SGC 100 mg/kg treated group, L_6: SGC 200 mg/kg treated group treated, L_7: SGA 250 mg/kg treated group, L_8: SGA 500 mg/kg treated group.

4. Discussion

A remedial tree called *Solanum giganteum Jacq*. was originated in Satara, Maharashtra, India. pharmacognostic, phytochemical, and antioxidant estimates were done in the previous work[35]. For the neuroprotective study, chloroform and alcoholic extracts were chosen based on the results of a previous *in vitro* antioxidant investigation[36]. Additionally, the SGA and SGC extracts of *Solanum giganteum Jacq.* underwent an oral acute and subacute toxicity assessment. The SGA extract is thought to be reasonably safe for both acute and subacute oral exposure. The experiment utilised effective dosages of 250 and 500 mg/kg (SGA). Acute oral toxicity was identified at a level of 2000 mg/kg during a subacute toxicity experiment that used a higher dose of the SG-chloroform extract at 500 mg/kg. The study utilized 100 and 200 mg/kg as effective levels (SGC)[37].

Aluminium chloride was used in the study to convince participants they had Alzheimer's disease. A neurotoxic substance labeled aluminium encourages the formation of oxidative radicals within the brain[38]. An increase in oxidative radicals could trigger deleterious processes that result in AD. After 28 days, rats that received $AlCl_3$ treatment exhibited significant reductions in food intake, locomotor activity, and rotation time on the rotarod, as well as longer times to attain the reward in the T maze test. In the aluminium chloride treated group, a significant rise in AchE and lipid peroxidation was also reported. SOD, catalase, and glutathione levels all significantly dropped in the aluminium chloride-treated group. This seemed to be caused by the deterioration of cholinergic neurons and an increase in oxidative stress over the built-in antioxidant system. To more precisely corroborate these findings, histological analysis of the brain tissue was also carried out. This demonstrated that the $AlCl_3$-intoxicated group had more nuclei with condensed chromatin, as well as gliosis and inflammation, both of which indicated damage to the neurons.

Groups treated with SGC and STD extracts from *Solanum giganteum* Jacq. showed a notable improvement in the behavior model. In comparison to the untreated group, the body weight of those who received an SGC 200 mg/kg dose increased significantly. The locomotor and rotarod activities increased with each dose of SGC and SGA. A 200 mg/kg dose of SGC resulted in a significantly lower level of AchE and oxidative stress indicators, such as lipid peroxidation, as well as significantly higher levels of brain-reactive chemicals including SOD, Catalase, and Glutathione. The fact that brain SOD, Catalase, and Glutathione levels have increased suggests that the extracts contain chemical elements that may have antioxidant action to prevent brain oxidation by lowering the quantity of oxidative free radicals.

DNA damage caused by $AlCl_3$ was also studied. DNA fragmentation increased after $AlCl_3$ induction, which suggests increased DNA damage. Apoptosis is frequently characterised by DNA damage. SGC and STD groups treated with the extracts lane exhibited decreased DNA fragmentation. It might be because extracts partially inhibit apoptosis. SGC 200 mg/kg significantly improved Alzheimer's models.

Aluminium is known to be a neurotoxic component that encourages the formation of oxidative radicals and a number of pro-inflammatory cascades in the brain[38]. The development of oxidative radicals may source deleterious events of ageing such as AD and because SGC 200 mg/kg proved its strength aligned with this neurotoxin mediator so it should be employed in dementia or AD.

The pharmacological, biochemical, histopathological, and DNA fragmentation analyses, it has been accomplished at the dose of 200 mg/kg *p.o.* of chloroform extract of *Solanum giganteum* Jacq. retained the probably protective outcome against aluminium chloride-induced dementia of Alzheimer's type in rats. SGC 200 mg/kg provides a considerable effect aligned with the

neuroinflammatory disorder since of its presence of phytoconstituent i.e., alkaloids.

For the treatment of neurological illnesses, Solanum species including *S. lyratum, S. khasianum, S. xanthocarpum, S. nigrum, S. tuberosum, S. gracile,* and *S. laciniatum* are employed and solasodine alkaloid was isolated by Solanum species[12-15]. Similar to the solasodine alkaloid present in the chloroform extract of *Solanum giganteum* Jacq. The neuroprotective action is shown by the chloroform extract of *Solanum giganteum* Jacq. maybe due to the presence of solasodine alkaloids. It is necessary to conduct more research to clarify the connection between dementia caused by $AlCl_3$ and the role of solasodine in neuronal abnormalities.

5. Conclusion

Neuroprotective action employed for chloroform extract of *Solanum giganteum* Jacq. on $AlCl_3$-induced behavioral parameters includes cognitive deficit and locomotor impairment. The *Solanum giganteum* Jacq. of chloroform extract was found to be also capable of treating oxidative stress and neuroinflammation in the hippocampus and cortical areas, restoring the biochemical modifications generated by aluminum. The neuroprotective action shown by the chloroform extract may be due to the presence of solasodine. To outline the importance of isolated alkaloids solasodine in the association with $AlCl_3$-mediated related dementia, more research is required.

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7. List of Abbreviations

SG - *Solanum giganteum*
SGC - *Solanum giganteum* chloroform extract
SGA - *Solanum giganteum* alcohol extract
STD - Standard Drug
p. o. - per oral
AD - Alzheimer's disease
NFTs - neurofibrillary tangles
SEM - Standard Error Mean
Mg - milligram
$AlCl_3$ - Aluminium chloride
AChE - Acetylcholinesterase
SOD - Superoxide dismutase
CPCSEA - The committee for control and supervision of experiments on animal

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