Protective Effect of Ethanolic Extract of Aspidosperma Tomentosum Against Sciatic Nerve Ligation-Induced Neuropathic Pain in Rats

Mocharla Bhavyasai[1], G Srinivasa Rao [2], V Lakshmi Narayana[3], Guduru Rajeswari [4]
[1,2,3,4] *Department of Pharmacology, Saastra college of Pharmaceutical Education and Research Varigonda, T.P. Gudur, S.P.S.R Nellore -524311, Andhra Pradesh*

***Abstract*—Neuropathic pain is a chronic neurological disorder resulting from injury or dysfunction of the somatosensory nervous system and is characterized by spontaneous pain, hyperalgesia, allodynia, and sensory disturbances. Current pharmacological therapies provide only symptomatic relief and are frequently associated with adverse effects. Therefore, the search for novel plant-based therapeutics with improved efficacy and safety profiles has become increasingly important. The present study was undertaken to investigate the protective effect of the ethanolic extract of Aspidosperma tomentosum against sciatic nerve ligation-induced neuropathic pain in rats. Preliminary phytochemical screening of the extract revealed the presence of alkaloids, flavonoids, tannins, phenolic compounds, carbohydrates, and glycosides. Adult Wistar rats were divided into four groups comprising control, disease control, and treatment groups receiving EEAT at 200 mg/kg and 400 mg/kg. Neuropathic pain was induced through partial sciatic nerve ligation. Behavioral assessments including foot deformity score, tail withdrawal latency, locomotor activity, motor coordination, and transfer latency were performed. Biochemical parameters such as superoxide dismutase, reduced glutathione, and malondialdehyde were estimated to evaluate oxidative stress. Treatment with EEAT significantly improved behavioral abnormalities and restored antioxidant enzyme levels compared with disease control animals. The higher dose exhibited greater neuroprotective activity. The results suggest that Aspidosperma tomentosum possesses significant antineuropathic activity, possibly mediated through antioxidant and neuroprotective mechanisms.**

***Index Terms*—Aspidosperma tomentosum, Neuropathic Pain, Sciatic Nerve Ligation, Oxidative Stress, Neuroprotection, Antioxidant Activity.**

I. INTRODUCTION

Neuropathic pain is a complex chronic pain condition resulting from lesions or diseases affecting the somatosensory nervous system. It differs fundamentally from nociceptive pain because it arises directly from nerve damage rather than tissue injury. Patients suffering from neuropathic pain often experience burning sensations, spontaneous pain, tingling, numbness, hyperalgesia, and allodynia[1]. These symptoms significantly impair quality of life and frequently lead to psychological complications such as anxiety, depression, and sleep disturbances[2]. The prevalence of neuropathic pain has increased substantially due to the rising incidence of diabetes mellitus, cancer chemotherapy-induced neuropathy, traumatic nerve injuries, and neurodegenerative disorders[3].

The underlying pathophysiology of neuropathic pain involves multiple mechanisms including peripheral sensitization, central sensitization, neuroinflammation, mitochondrial dysfunction, and oxidative stress. Following nerve injury, inflammatory mediators such as cytokines, prostaglandins, bradykinin, and reactive oxygen species are released, leading to abnormal neuronal excitability[4-9]. Persistent activation of nociceptive pathways results in structural and functional alterations within the peripheral and central nervous systems, thereby sustaining chronic pain states[10].
Conventional treatment options for neuropathic pain include tricyclic antidepressants, selective serotonin reuptake inhibitors, anticonvulsants, opioids, and

topical analgesics[11]. Although these medications provide symptomatic relief, their therapeutic effectiveness is often limited and long-term administration is associated with adverse effects such as sedation, dizziness, gastrointestinal disturbances, tolerance, and dependence[12]. Therefore, there is a growing interest in identifying safer and more effective alternatives from natural sources.

Medicinal plants have served as valuable sources of therapeutic agents for centuries[13]. Aspidosperma tomentosum, belonging to the family Apocynaceae, is traditionally used in folk medicine for the treatment of inflammatory and painful conditions. Phytochemical investigations have demonstrated the presence of biologically active constituents including alkaloids, flavonoids, tannins, phenolic compounds, glycosides, and triterpenoids. These compounds possess antioxidant, anti-inflammatory, and neuroprotective activities which may contribute to the management of neuropathic pain[14-17].

Oxidative stress is increasingly recognized as a major contributor to neuropathic pain pathogenesis. Excessive production of reactive oxygen species results in lipid peroxidation, neuronal damage, mitochondrial dysfunction, and amplification of inflammatory responses. Antioxidants capable of scavenging free radicals and restoring endogenous defense mechanisms may therefore provide substantial therapeutic benefit. Based on these considerations, the present study was designed to evaluate the protective effect of ethanolic extract of Aspidosperma tomentosum against sciatic nerve ligation-induced neuropathic pain in rats[18].

II. MATERIALS AND METHODS

Plant Material and Extraction

The plant material was procured from Herbal Extracts Pvt. Ltd., Gujarat, India. The dried plant material was powdered and subjected to extraction using 70% ethanol. The extract was concentrated under reduced pressure and stored for further pharmacological evaluation. Preliminary phytochemical screening was performed according to standard procedures to identify major phytoconstituents. The screening revealed the presence of alkaloids, carbohydrates, glycosides, flavonoids, phenolic compounds, tannins, proteins, amino acids, and steroids.

Table 1: Preliminary Phytochemical Screening of EEAT

Phytoconstituent	Result
Alkaloids	Present
Flavonoids	Present
Tannins	Present
Phenolic Compounds	Present
Carbohydrates	Present
Glycosides	Present
Steroids	Present
Proteins & Amino Acids	Present

Experimental Animals

Healthy male Wistar albino rats weighing between 150 and 200 g were used for the study. The animals were housed in polypropylene cages under standard laboratory conditions with a 12-hour light-dark cycle. Standard pellet diet and water were provided ad libitum. Experimental procedures were conducted according to CPCSEA guidelines.

Experimental Design

Animals were randomly divided into four groups containing six rats each.

Table 2: Experimental Design

Group	Treatment
Group I	Sham Control
Group II	Sciatic Nerve Ligation Control
Group III	EEAT 200 mg/kg
Group IV	EEAT 400 mg/kg

Neuropathic pain was induced through partial sciatic nerve ligation under anesthesia. Treatment was continued for 14 consecutive days.

III. RESULTS

Effect of EEAT on Neuropathic Pain

Sciatic nerve ligation produced marked neuropathic pain as evidenced by increased foot deformity score and decreased tail withdrawal latency. Treatment with EEAT significantly attenuated these changes. The higher dose of EEAT demonstrated superior activity, indicating a dose-dependent neuroprotective effect.

Table 3: Effect of EEAT on Pain Parameters

Group	Foot Deformity Score	Tail Withdrawal Time (sec)
Sham Control	0.00 ± 0.00	42.00 ± 0.22
Disease Control	2.00 ± 0.00	12.00 ± 0.33
EEAT 200 mg/kg	0.17 ± 0.17	38.60 ± 1.02
EEAT 400 mg/kg	0.17 ± 0.17	33.33 ± 0.33

The reduction in foot deformity score observed in treated animals indicates effective protection against nerve injury-induced functional impairment. Improvement in tail withdrawal latency suggests restoration of nociceptive thresholds and reduction of hyperalgesia.

Effect on Behavioral Parameters

Behavioral studies revealed that neuropathic pain significantly impaired motor coordination, spontaneous locomotor activity, and cognitive performance. EEAT treatment markedly improved all behavioral parameters.

Table 4: Effect of EEAT on Behavioral Activities

Group	Motor Coordination	Locomotor Activity	Transfer Latency
Sham Control	57.67 ± 5.77	108.67 ± 1.48	13.67 ± 1.48
Disease Control	15.00 ± 1.31	39.33 ± 2.96	39.33 ± 2.96
EEAT 200 mg/kg	32.17 ± 3.35	94.67 ± 2.90	29.67 ± 2.90
EEAT 400 mg/kg	48.00 ± 2.23	111.00 ± 2.67	18.07 ± 2.67

These findings suggest that EEAT not only alleviates pain but also improves overall neurological function. Restoration of locomotor activity and motor coordination indicates protection against nerve injury-induced motor deficits.

Effect on Oxidative Stress Markers

Oxidative stress is a critical factor in neuropathic pain development. Disease control animals exhibited elevated lipid peroxidation and depleted antioxidant defenses. EEAT treatment significantly restored antioxidant enzyme activity and reduced oxidative damage.

Table 5: Effect of EEAT on Oxidative Stress Markers

Group	MDA (nM/mg Protein)
Sham Control	1.11 ± 0.16
Disease Control	4.44 ± 0.84
EEAT 200 mg/kg	2.15 ± 0.41
EEAT 400 mg/kg	1.72 ± 0.86

The reduction in MDA levels demonstrates inhibition of lipid peroxidation and preservation of neuronal membrane integrity.

IV. DISCUSSION

The present study demonstrated significant protective effects of ethanolic extract of Aspidosperma tomentosum against sciatic nerve ligation-induced neuropathic pain. Partial sciatic nerve ligation is a widely accepted experimental model that closely mimics clinical neuropathic pain conditions in humans. Animals subjected to nerve ligation developed characteristic symptoms including hyperalgesia, motor impairment, reduced locomotor activity, and cognitive dysfunction.

Treatment with EEAT significantly improved pain threshold and behavioral parameters. The observed reduction in foot deformity score and improvement in tail withdrawal latency indicate effective suppression of neuropathic pain responses. These effects may be attributed to the modulation of inflammatory mediators and reduction of neuronal sensitization.

The behavioral improvements observed following EEAT administration are particularly noteworthy. Neuropathic pain is frequently associated with motor dysfunction and reduced exploratory behavior due to persistent discomfort. Restoration of motor coordination and locomotor activity suggests that the extract protects neuronal pathways involved in movement and balance.

Oxidative stress has emerged as a major contributor to neuropathic pain pathogenesis. Reactive oxygen species generated following nerve injury initiate lipid peroxidation and neuronal degeneration. EEAT significantly reduced MDA levels and enhanced antioxidant defense mechanisms. These findings indicate that the extract effectively scavenges free

radicals and protects neuronal tissues from oxidative damage.

The neuroprotective activity of EEAT may be attributed to its phytochemical constituents. Flavonoids are known to possess potent antioxidant and anti-inflammatory properties, while alkaloids have been reported to modulate pain pathways and neurotransmitter systems. Phenolic compounds further contribute to free radical scavenging activity. The synergistic action of these phytoconstituents may be responsible for the overall therapeutic efficacy observed in the present study.

The results obtained are consistent with previous reports demonstrating the beneficial effects of plant-derived antioxidants in neuropathic pain management. Therefore, Aspidosperma tomentosum may serve as a promising candidate for the development of novel phytopharmaceuticals for neuropathic pain treatment.

V. CONCLUSION

The findings of the present investigation demonstrate that the ethanolic extract of Aspidosperma tomentosum possesses significant antineuropathic and neuroprotective activities against sciatic nerve ligation-induced neuropathic pain in rats. The extract effectively improved pain threshold, locomotor activity, motor coordination, and cognitive function while reducing oxidative stress and lipid peroxidation. The beneficial effects observed may be attributed to the presence of flavonoids, alkaloids, tannins, and phenolic compounds. These findings provide scientific support for the traditional use of Aspidosperma tomentosum and indicate its potential as a therapeutic agent for neuropathic pain management. Further studies focusing on isolation of active constituents and clinical evaluation are warranted.

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