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Original Article

Antidepressant Potential of *Albizzia lebbeck* SLNs

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ABSTRACT

Background: To assess *in vivo* antidepressant of Ethanolic extract of *Albizzia lebbeck* (L.) own their family Fabaceae the plant's primary constituents Triterpenes, glycosides, saponins, flavonoids, and indole alkaloids are the main components of *Albizzia lebbeck* (L.), a member of the Fabaceae family, which is used to evaluate the *in vivo* antidepressant properties of its ethanolic extract. Reports on the pharmacological effects of anti-inflammatory, antioxidant, cytotoxic, anti-genotoxic, sedative and antiepileptic, anti-convulsant, anti-helminthic, anti-microbial, anti-fungal, and antipyretic substances can be found in the literature review. It has been reported that *Albizzia lebbeck* has anti-epileptic properties. **Materials and Methods:** The current study is intended to have antidepressant effects on test animals. The impact of an *Alzzia lebbeck* (L.) leaf ethanol extract on Swiss albino mice's depression; For 21 days in a row, Swiss albino mice were repeatedly exposed to moderate stress. For 21 days, various groups of stressed and unstressed mice received oral doses of imipramine (15 mg/kg) and EEAL (200 and 400 mg/kg). The Open Field Test (OFT) and the Tail Suspension Test (TST) were performed locomotory one hour after the mice were given oral doses of 200 or 400 mg/kg of EEAL&ASLNs to assess their inclination toward depressive-like behavior. **Results:** After receiving EEAL (200 mg/kg), ASLNs (100, 200, 400 mg/kg), and imipramine (15 mg/kg) for 21 days, the immobility duration of both stressed and unstressed mice was significantly reduced. Both TST and OFT showed the previously mentioned effect. *Albizzia lebbeck* (L.) ethanol leaf extract dramatically raised catalase levels while lowering MDA levels. After being treated with EEAL (200 mg/kg) and ASLNs, the serotonin levels of both calm and nervous mice significantly increased compared to their vehicle-treated counterparts. **Conclusion:** The ASLNs demonstrated potent antidepressant-like effects in both stressed and relaxed mice, possibly lowering oxidative stress.

Keywords: Antidepressant, Tail suspension, Open field test, *Albizzia lebbeck*.

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INTRODUCTION

Life despair is frequently characterized by a deep sense of emptiness that is strongly associated with neurotic disorders, decreased participation in day-to-day activities, and, in extreme situations, suicidal thoughts. profound sense of helplessness, which governs and manages the operations of every organ in the body (Sudan, P. *et al*., 2024). Day, according to the WHO (2008), despair is a very common disorder that affects about 121 million people worldwide. The pharmacological profile and genetic efficacy of different herbal medicines are becoming better understood. The illness is both biologically and clinically complex (Murugan, P. *et al*., 2021). One of the most prevalent and expensive mental illnesses in the world, sadness stems from a lack of hope throughout one's life (World Health Organization, 2001). Furthermore, the World Health Organization has determined that hopelessness is the quarter most significant cause of illness globally, followed by lower respiratory infections, prenatal conditions, and HIV/AIDS (Millan, M. J. 2004). Reducing side effects like sexual dysfunction, insomnia, and weight gain is crucial because these problems frequently impair patient adherence and treatment results, even though newer drugs-like fluoxetine and Selective Serotonin Reuptake Inhibitors (SSRIs)-have better safety profiles than first-generation medications like imipramine (Bhattacharya, S. K. *et al*., 1999). Interestingly, most people agree that the perfect antidepressant should not only be more effective but also affordable and have a quick start to work (Song, S. *et al*., 2017).

MATERIALS AND METHODS

Drugs and Chemicals

The *Albizzia lebbeck* plant's leaves were gathered. The Central Ayurveda Research Institute in Bangalore, 560109, authentically purchased RRCBI-1637. additional Imipramine was obtained from a local medical supply store in Bengaluru. The chemicals

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employed chemicals from Sigma-Aldrich, including ethanol, methanol, chloroform, acetone, stearic acid, and polyvinyl alcohol.

Preparation of Extract of *Albizzia lebbeck* (L.)

The of *Albizzia lebbeck* was thoroughly rinsed with tap water and then parched in shade at 25°C. Once dried, the roots were finely ground into powder form. This powdered material was subsequently passed through a 1 mM sieve to prepare for extraction.

Method of Extraction

Using a Soxhlet apparatus, 440 g of this powder was used for extraction with 1.2 L of methanol. After that, the resultant extract was dried by evaporation, producing a consistent extract weight of 11.3%. Until it was needed again, the finished extract was kept in the refrigerator. The Standard protocols were being followed for phytochemical screening. Mayer's and Dragendorff's tests for alkaloids, Borntrager's test for glycosides, the foam test for saponins, the lead acetate and ferric chloride tests for tannins, and the NaOH test for flavonoids were among the tests conducted. The extract was then weighed, examined, and vacuum-evaporated.

Sample preparation

After dissolving 10 mg of the sample extract in 2 mL of ethanol, it was filtered and injected. The mobile phase was composed of acetonitrile (organic modifier, B) and 0.1% formic acid in water (aqueous phase, A). It was delivered at a flow rate of 0.2 mL/min in the following gradient: 2% B for 1 min, 2-50% B for 1 to 6 min, 50-95% B for 6 to 12 min, held for 4 min, 95-2% B for 16 to 17 min, and held at 2% B for 3 min. The column oven was kept at 22° while a 5 µL sample was injected.

Preparation of solid lipid Nano-particles

A mixture of acetone and ethanol (10 mL each) was heated to 60°C in a water bath to dissolve 30 mg of Stearic Acid (SA). After adding 10 mg of ethanolic extract, the mixture was agitated for two hours and subjected to a 30-min sonication. The resultant mixture was mechanically stirred while being poured into 100 mL of cold, refrigerated 1% polyvinyl alcohol solution. After being centrifuged at 1000 rpm and ultrasonically cleaned, the solidified product was rinsed three times with deionized water. The obtained Solid Lipid Nanoparticles (ASLNs) were gathered and utilized for additional characterization (Shahwan, T. *et al*., 2011) (Figure 1).

Models to evaluate the antidepressant activity

Acute toxicity test: According to OECD guidelines, Swiss albino mice were used in the oral acute toxicity test of the ethanol leaf extract (423). Animal groups were given doses of 500, 1000, 2000, and 3000 mg/kg b.w. after a 12-hr fast in four test groups (*n*=5). Following gavage, the mice were housed in different cages with unrestricted access to food and water. For the first four hours and the following seven days following treatment, every animal was closely monitored for mortality, allergic reactions, and any unusual behaviors (Shang *et al*., 2015).

Experimental animals

Experimental rats were categorized into 6 groups, *n*=6/group: For the study, 36 male Wistar albino rats weighing between 150 and 200 g were chosen, and they were split up into six groups (*n*=6) for a 21-day treatment period under standard conditions. Group 1 is in charge. Imipramine (15 mg/kg, p.o.) was administered to Group II. Groups IV through VI were given ASLN extract at doses of 100, 200, and 400 mg/kg body weight/day, as explained below, while Group III was given an extract of *Albizia lebbeck* (200 mg/kg, p.o.). The animals were housed in controlled environments with a 12-hr light/dark cycle (12L:12D), a relative humidity of 55±2% and a temperature of 23±2°C. They were given unlimited access to drinking water and standardized pellet feed. The Institutional Animal Ethics Committee (IAEC), Reg. No. 377/po/ReBi/S/2001/CPCSEA, gave its approval to the experimental protocol. Every experimental procedure was carried out in accordance with the CPCSEA guidelines. Dose Selection for Pharmacological Activity: The selected doses for evaluating the antidepressant activity of *Albizzia lebbeck* (L.) and Imipramine were determined based on findings from acute toxicity studies available in the literature. The doses were set at 250, 500 mg/kg (Shang *et al*., 2015). While Imipramine was administered at 10 mg/kg.

Tail suspension test

The Tail Suspension Test (TST) was conducted following the method outlined by Steru *et al*., This test relies on the observation that rats, when suspended upside down, exhibit characteristic immobility, which is considered indicative of depression. After administering the respective drug, rats were suspended by their tails using thread and adhesive tape, positioned 50 cm above the floor, with the tape placed about 2 cm from the tip of the tail. Immobility duration was recorded during the final 4 min of a 6-min period (Nochaiwong, S., *et al*., 2021).

Open field test

Rats' general activity and exploratory behavior were evaluated using the open field test. A clear plexiglass box that was 40 cm long, 40 cm wide, and 40 cm high made up the apparatus (Demissie, S. *et al*., 2017). The floor was separated into 16 equal squares. After being positioned in the middle of the field, each rat was free to roam around. By counting the times the rat moved its four paws to occupy a single square, the number of crossings-both in the central and peripheral squares-was determined. For five minutes, the entire activity was monitored and documented (Kulkarni, S. K. 1987).

Locomotor activity

An actophotometer, which uses photoelectric cells coupled to a counter, was used to measure locomotor activity in naïve pretreated mice. A count was recorded each time the animal diverted the light beam that was aimed at the photocell. The animal's locomotor activity was gauged by counting the number of beam interruptions over a 10-min period (Hawiset, T., *et al.*, 2022).

Histopathological study

The procedure described by Molina *et al.*, (1990) was effective in inducing stress-related behavior. Animals were exposed to a stress paradigm once daily for 21 consecutive days (D1-D21), which included (12°C for 5 min) the rats were anesthetized and decapitated, and their brains were carefully extracted. The brain tissues were fixed in 10% buffered neutral formalin for histopathological evaluation. After fixation, the tissues were processed, embedded in paraffin, and stained using Hematoxylin and Eosin (H&E) dyes (Hawiset, T., *et al.*, 2022).

Estimation of oxidative stress

Superoxide activists were caused in a 5 mL Tris-HCl buffer (16 mM, pH 8.0) comprising 1 mL of NBT (300 µM) solution, 1 mL of NADH (936 µM) solution, 2 mL of the sample solution, and 2 mL of Tris-HCl buffer contributing to oxidative stress, the superoxide anion shaped from the PMS/NADH connection reaction reduces NBT, subsequent in a blue color. The decrease in absorbance at 560 nm in the presence of antioxidants indicates the consumption of superoxide anions in the reaction mixture (Hawiset, T., *et al.*, 2022).

HYDROXYL RADICAL SCAVENGING ASSAY

The response mixture (1.0 mL) was equipped by joining 100 µL of 2-Deoxy-D-Ribose, 500 µL of the extract, 200 µL of EDTA (1.04 mM) and FeCl3 (200 mM) in a 1:1 ratio, 100 µL of H2O2 (1.0 mM), and 100 µL of ascorbic acid (1.0 mM). The combination be located nurtured at 37°C for 1 hr. Subsequently, 1.0 mL of TBA (1%) and 1.0 mL of TCA (2.8%) were additional, and the solution was incubated at 100°C for 20 min. Hydroxyl group radicals, potent sensitive oxygen species cause injury to cell films by reacting with polyunsaturated lean acid moieties of phospholipids. This assay uses the ascorbic acid-iron-EDTA model to produce hydroxyl group extremists in an aqueous system, where ascorbic acid, iron, and EDTA cooperate to produce these radicals. (Ellman, G. L *et al.*, 1961). The brain tissue was weighed and homogenized in 0.1 M phosphate buffer (pH 8.0) 0.4 mL aliquot of homogenate is added to a cuvette containing 2.6 mL phosphate buffer (0.1 M, pH 8.0) & 100 µL of DTNB. The contents in the cuvette are mixed thoroughly and absorbance is measured at 412 nm in a spectrophotometer. When absorbance reaches a stable valve, it is recorded as a basal reading. 20 µL of the substrate (acetylthiocholine) was added and a change in absorbance was recorded for 10 min at time intervals. (Navaneetha Krishnan, M. *et al.*, 2024). Change in absorbance per min was noted. The final reading of enzyme activity is expressed as µ moles/min/mg tissue.

The enzyme activity is calculated using the following formula:

$$R = \frac{\text{absorbance/min}}{1.36 \times 10^{-4}}$$

Statistical Analysis

Each group had six rats (n=6), and the results were expressed as Mean±Sem. Graphpad Prism (version 10) was used to conduct statistical analyses. Tukey's test was used to evaluate group differences after ANOVA. By contrasting the untreated control group with the other groups, statistical significance was determined; p-values less than 0.001 were considered highly significant.

RESULTS

The concentration and yield of *Albizia lebbeck* extracts are significantly impacted by the choice of solvent. Water is perfect for extracting polar compounds because it yielded the highest concentration and yield. Methanol and ethanol gave slightly lower yields but were effective in extracting a broader range of phytochemicals. The solvent should be selected based on the

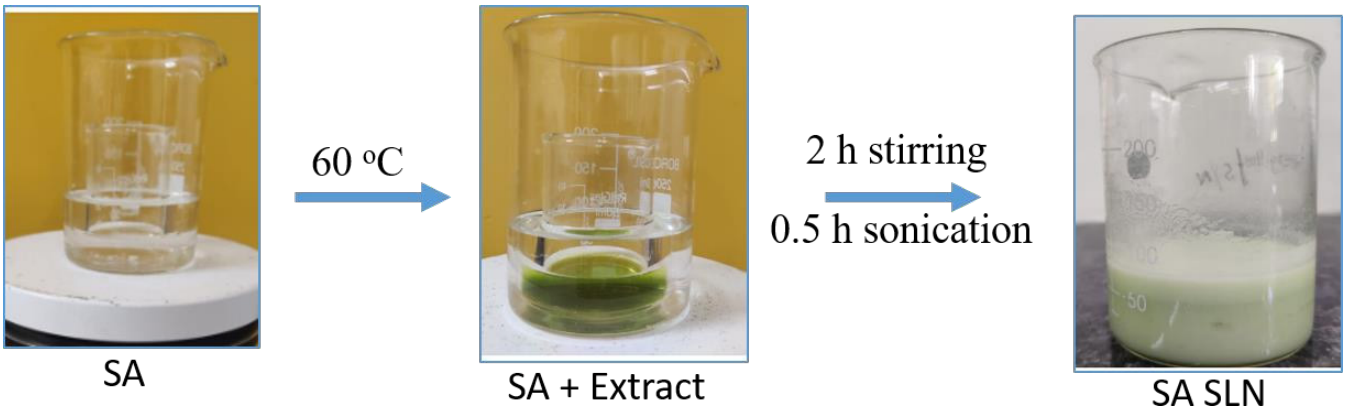

Figure 1: Preparation of ALSNs.

targeted phytochemical profile for the intended application Phytochemical screening. The phytochemical constituents of the plant extracts were present in the solid-lipid conjugated plant extract nanoparticles also, The result showed that none of the constituents were degraded during the preparation of nanoparticles (Siddiqui A, *et al*., 2015) (Table 1).

Using LC-MS/MS, the chemical profile of *Albizzia lebbeck* (L.) was examined, and a number of bioactive compounds were found (Table 2, Figure 2). Trichothecenes, 8-prenylated xanthones, flavonoids, oligopeptides, triterpenoids, isoindolones, 3-alkylindoles, and ketones were noteworthy among them. Numerous of these substances have been shown to have antidepressant properties in the past, most likely as a result of altering neurotransmitter systems. They are believed to improve serotonin binding in particular, which may provide a treatment approach for depression. Of the more than 22 phytochemicals found in the plant extract, four flavonoids were chosen for additional research because of their important role in determining the effects of antidepressants (Y. Liu *et al*., 2017) (Table 2).

Behavioral Studies

The extract's antidepressant potential was further confirmed by the behavioral despair preclinical model, which measures antidepressant efficacy mobility time in the tail suspension test. According to this model, immobility stress represents a depressive-like state (Siddiqui, A. *et al.*, 2015), as shown in Table 3 and Figure 3, and the test extract's ability to reduce immobility suggests that this state has reversed. Monitoring locomotor activity is a tried-and-true technique for assessing the effects of CNS medications. While decreased activity indicates CNS depression, increased movement usually indicates heightened CNS excitability (Table 4). The open field test revealed a marked increase in exploratory behaviors (walling, rearing, and line crossing), which implies that the extract from *Albizia lebbeck* stimulates the central nervous system (T. Hawiset and others, 2022) (Figure 4). When compared to vehicle-treated controls, the ethanolic extract of *Albizzia lebbeck* leaves showed a definite, dose-dependent decrease in immobility time in both the open field locator activity and the Tail Suspension Test (TST). The extract dramatically reduced immobility at 200 mg/kg and 400 mg/kg, which is consistent with the mood-balancing effects of common antidepressants like imipramine. Its bioactive components may also alter the neural pathways linked to behavioral despair. Notably, Table 5 demonstrates that these effects happen without influencing locomotor activity, highlighting the extract's antidepressant-like actions' specificity (Demissie, S. *et al*., 2017) (Figure 5).

Estimation of oxidative stress

According to the study, imipramine has the strongest effect on AChE activity in the rat brain, while *Albizzia lebbeck*-loaded nanoparticles can also affect it (Table 6) (G. L. Ellman *et al*., 1961). The results point to possible medicinal uses for these compounds in cholinergic activity modulation (Figure 6).

Histological Experiments

Hematoxylin and Eosin histological analysis revealed that the control group's neurons were normal. The chromatin was preserved and the cell outlines were intact. Additionally, the ALSNs100 group displayed largely healthy neurons. There were no signs of neurofibrillary tangles or cytoplasmic vacuolization. According to Amara *et al*., (2002), some neurons were hyperchromatic. One pyramidal neuron had a condensed nucleus and looked shrunken. (pyknosis), which is characterized by hydrophic degeneration and perinuclear halos surrounding glial cells, is a sign of neurodegeneration/apoptosis (Figure 7).

Antioxidant evaluations

Hydroxyl radical scavenging assay

The hydroxyl radical scavenging assay showed that SLNA had moderate antioxidant activity (IC_{50}: 709.57 µg/mL) compared to ascorbic acid (IC_{50}: 65.57 µg/mL), indicating lower potency. However, at 60 µg/mL, SLNA's activity was comparable to ascorbic acid.

DISCUSSION

For the intended use, the solvent should be chosen according to the desired phytochemical profile (Phytochemical screening). The solid-lipid conjugated plant extract nanoparticles contained the phytochemical constituents of the plant extracts as well. The outcome demonstrated that none of the constituents were broken down during the nanoparticle preparation process. There were over 22 phytochemicals in the plant extract., with four flavonoids selected for further study due to their significant role in influencing antidepressant effects. The extract's antidepressant potential was further confirmed by the behavioral despair preclinical model, which measures antidepressant efficacy mobility time in the tail suspension test. According to this model,

Table 1: The extraction data for *Albizia lebbeck* using ethanol, methanol, and water solvents reveals insights into the efficiency and selectivity of each solvent.

Solvent	Yield (%)	Extract Mass	Solvent Volume	Concentration (g/mL)
Water	20.66	2.06 g	2.0 mL	1.03
Ethanol	14.64	1.46 g	4.0 mL	0.365
Methanol	13.60	1.36 g	2.5 mL	0.544

Table 2: **Phytoconstituents in the sample were identified based on their retention time, compound name, molecular formula.**

Sl. No.	Retention time (min)	Name of the compound	Molecular formula	Molecular Ion (m/z [M-H]⁻)
1	3.831	Trichothecenes	$C_{29}H_{34}O_{10}$	565.2039
2	3.882	8-prenylated xanthones	$C_{24}H_{26}O_6$	433.1604
3	3.932	Flavonoid 8-C-glycosides	$C_{26}H_{28}O_{15}$	581.207
4	4.437	Xanthones	$C_{16}H_{14}O_5$	287.0902
5	4.589	Hydroxybenzoic acid derivatives	$C_{12}H_{14}O_3$	207.1028
6	4.841	Oligopeptides	$C_{47}H_{79}N_9O_8$	898.6036
7	4.892	Triterpene saponins	$C_{60}H_{95}N_3O_{19}$	1162.67
8	5.094	Hydroxycinnamic acids	$C_9H_8O_4$	181.1536
9	5.195	Triterpenoids	$C_{63}H_{106}O_{30}$	1365.677
10	5.296	Iso indolones	$C_{25}H_{35}NO_5$	468.2174
11	5.346	3-alkylindoles	$C_{17}H_{26}ClN_3O_2S$	336.1738
12	6.71	Ketones	$C_{17}H_34O$	277.2512
13	6.811	Medium-chain hydroxy acids and derivatives	$C_{24}H_{38}O_6$	445.2558
14	7.215	Androgens and derivatives	$C_{19}H_{30}O_2$	291.2317
15	7.266	Amphetamines and derivatives	$C_{21}H_{35}NO_2$	351.2939
16	7.619	Gingerols	$C_{17}H_{26}O_4$	277.1762
17	8.276	Fatty alcohols	$C_{22}H_{46}O$	365.3135
18	8.428	1,3,5-triazines	$C_3H_6N_6$	149.0505
19	8.933	Androgens and derivatives	$C_{19}H_{30}O_2$	291.2387
20	9.286	Cholesterols and derivatives	$C_{32}H_{56}N_2O_2$	501.4342
21	9.488	Steroid glucuronide conjugates	$C_{30}H_{48}O_{11}$	607.3091
22	9.539	Long-chain fatty alcohols	$C_{17}H_{36}O$	279.2723

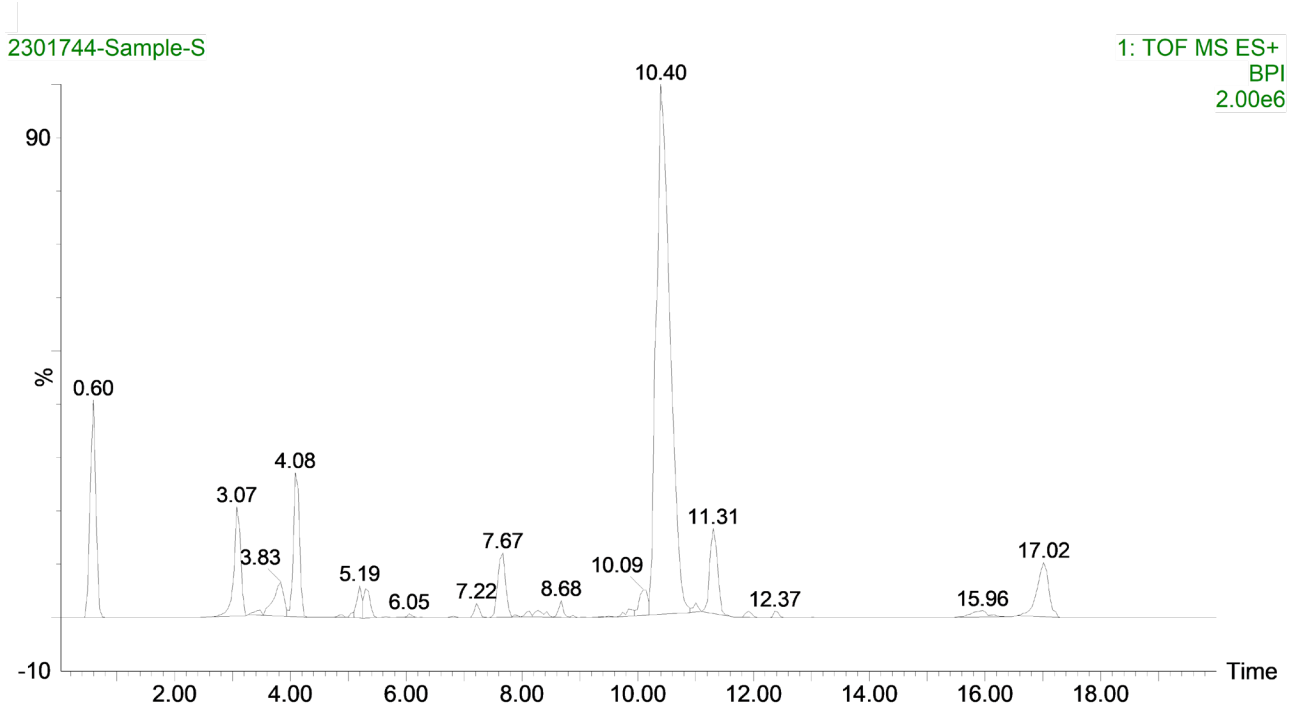

Figure 2: LCMS/MS chromatogram of Al.

immobility stress represents a state akin to depression (Table 3) and (Figure 3). The test extract's ability to reduce immobility suggests that this state has reversed. Monitoring locomotor activity is a tried-and-true technique for assessing the effects of CNS medications. Higher CNS excitability is usually reflected in increased movement., whereas a decline in activity points to CNS depression (Table 4). The open field test revealed a marked increase in exploratory behaviors (walling, rearing, and line crossing), which implies that the extract from *Albizia lebbeck* stimulates the central nervous system (T. Hawiset and others, 2022) (Figure 4). In both the open field and Tail Suspension Test (TST), the ethanolic extract of *Albizzia lebbeck* leaves showed a definite, dose-dependent decrease in immobility time. Locomator activity in contrast to controls treated by vehicles. The extract dramatically reduced immobility at 200 mg/kg and 400 mg/kg, which is consistent with the mood-balancing effects of common antidepressants like imipramine. Its bioactive components may also alter the neural pathways linked to behavioral despair. Notably, Table 5 demonstrates that these effects take place independently of locomotor activity. According to the study,

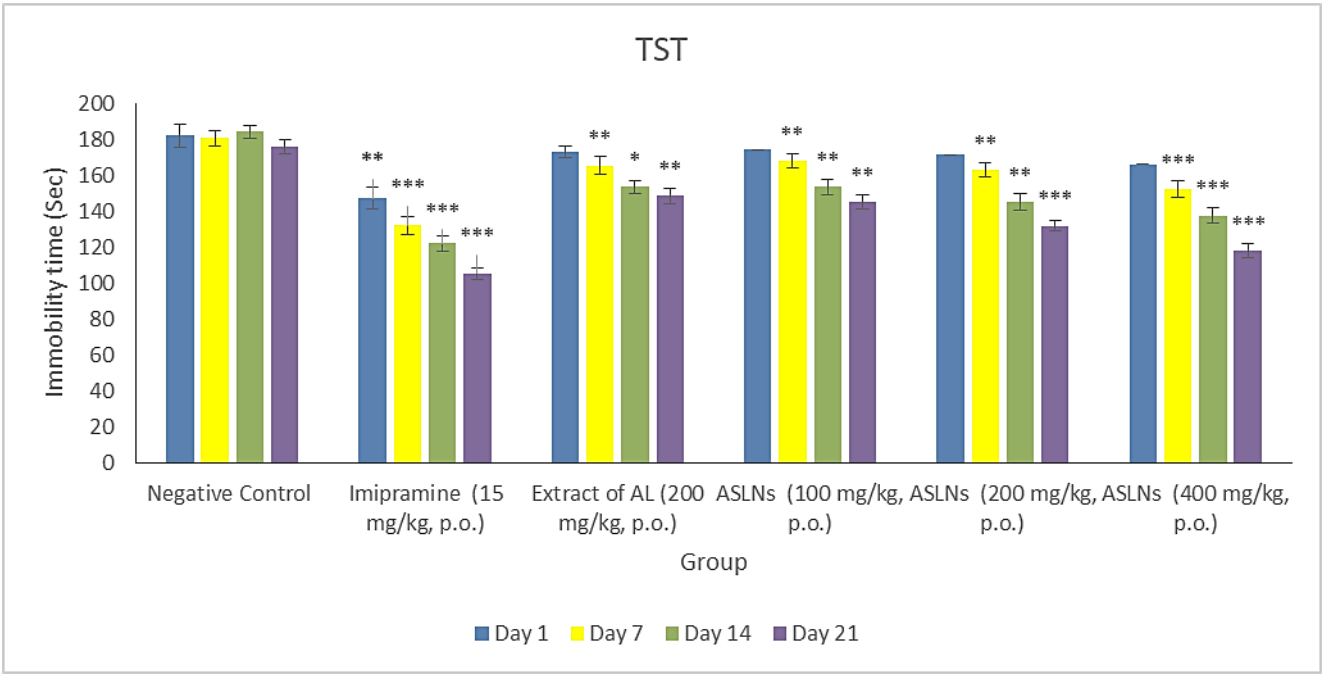

Figure 3: Effect of drugs on tail suspension in rats.

Table 3: Effect of drugs on tail suspension model.

Group	Treatment	Immobility time at weekly interval (Sec)			
		Day 1	Day 7	Day 14	Day 21
I	Control receives vehicle	182.32±6.53	180.76±4.39	184.32±3.82	176.32±4.03
II	Imipramine (15 mg/kg, p.o.)	147.43±5.83**	132.43±5.04***	122.37±4.27***	105.39±3.08***
III	Extract of *Albizzia lebbeck* (200 mg/kg, p.o.)	173.24±5.54.	165.65±4.77**	153.65±3.85*	148.69±4.15**
IV	ASLNs (100 mg/kg, p.o.)	174.32±5.29.	168.25±4.04**	153.78±4.34**	145.37±3.58**
V	ASLNs (200 mg/kg, p.o.)	171.53±5.22.	163.15±3.97**	145.34±4.37**	132.12±3.14***
VI	ASLNs (400 mg/kg, p.o.)	166.38±5.29*.	152.32±4.78***	137.78±4.05***	118.26±3.76***

All values are presented as mean ± Standard Error of the Mean (SEM), with a sample size of six (n=6). Statistical analysis was conducted using one-way Analysis of Variance (ANOVA), followed by Dunnett's multiple comparison test to identify significant differences between treatment groups and the control group. A p-value of less than 0.05 (*p<0.05) was considered statistically significant when compared to the control group.

Table 4: Effect of drugs on open field test.

Group	Treatment	No. of line crossing at weekly interval (Sec)			
		Day 1	Day 7	Day 14	Day 21
I	Control receives vehicle	84.56±3.54	86.23±3.77	85.29±2.88	87.43±3.32
II	Imipramine (15 mg/kg, p.o.)	103.29±2.45*	108.51±3.65**	115.36±2.56**	118.02±3.67***
III	Extract of A*lbizzia lebbeck* (200 mg/kg, p.o.)	94.06±4.06	96.76±3.35	99.62±3.56*	103.56±3.47*
IV	ASLNs (100 mg/kg, p.o.)	94.34±3.53	95.34±3.72	98.05±3.27	103.23±3.75*
V	ASLNs (200 mg/kg, p.o.)	93.25±4.87	96.46±3.87	103.45±3.02*	105.63±3.28**
VI	ASLNs (400 mg/kg, p.o.)	97.34±3.67	101.35±3.34*	107.76±3.44*	110.54±3.20***

All the values were expressed in Mean±SEM (n=6). The statistical analysis was carried out using one way ANOVA. Significant after Analysis of Variance (ANOVA) followed by Dunnett test. *$p<0.5$, when compared to control group.

Table 5: Effect of drugs on locomotor activity.

Group	Treatment	Count at weekly interval (Sec)			
		Day 1	Day 7	Day 14	Day 21
I	Control receives vehicle	175.35±5.28	169.43±4.27	175.37±3.13	179.26±3.37
II	Imipramie (15 mg/kg, p.o.)	242.03±4.87***	265.34±5.15***	287.35±4.06***	291.58±4.16***
III	Extract of A*lbizzia lebbeck* (200 mg/kg, p.o.)	204.65±5.27**	233.43±4.27***	232.37±3.13***	242.26±3.37***
IV	ASLNs (100 mg/kg, p.o.)	203.35±5.28**	229.43±4.27***	235.37±3.13***	239.26±3.37***
V	ASLNs (200 mg/kg, p.o.)	222.23±4.36***	234.39±3.98***	243.76±3.37***	251.54±3.08***
VI	ASLNs (400 mg/kg, p.o.)	225.47±5.18***	248.15±4.75***	254.36±3.88***	268.56±3.23***

All the values were expressed in Mean±SEM (n=6). The statistical analysis was carried out using one way ANOVA. Significant after Analysis of Variance (ANOVA) followed by Dunnett test. *p<0.5, when compared to control group.

imipramine has the strongest effect on AChE activity in the rat brain, while *Albizzia lebbeck*-loaded nanoparticles can also affect it (Table 6) (G. L. Ellman *et al*., 1961). The results point to possible medicinal uses for these compounds in cholinergic activity modulation (Figure 6). Hematoxylin and Eosin histological analysis revealed that the control group's neurons were normal. The chromatin was preserved and the cell outlines were intact. Additionally, the ALSNs100 group displayed largely healthy neurons. There were no signs of neurofibrillary tangles or cytoplasmic vacuolization. According to Amara *et al*., (2002), some neurons were hyperchromatic. One pyramidal neuron had a condensed nucleus and looked shrunken. (pyknosis), which is characterized by hydrophic degeneration and perinuclear halos surrounding glial cells, is a sign of neurodegeneration/apoptosis (Figure 7). Solid Lipid Nanoparticles of *Albizzia lebbeck* (SLNA) were tested for antioxidant capacity using the hydroxyl essential searching assay. With an IC_{50} value of 709.57±0.23 µg/mL, SLNA showed a comparatively moderate scavenging activity in this assay, which is indicative of the level of attention required to stop 50% of the hydroxyl radicals in the system. SLNA was found to be less effective at neutralizing hydroxyl radicals when compared to the standard antioxidant, ascorbic acid, which displayed a significantly lower IC_{50} value of 65.57±0.21 µg/mL (Figure 8). According to Priyanga *et al*., (2017), SLNA's higher IC_{50} value indicates that it is less effective than ascorbic acid. The antioxidant capacity of SLNA is assessed using the Hydroxyl Radical Scavenging Assay, which shows that at 60 µg/mL, SLNA's antioxidant capacity is comparable to ascorbic acid's.

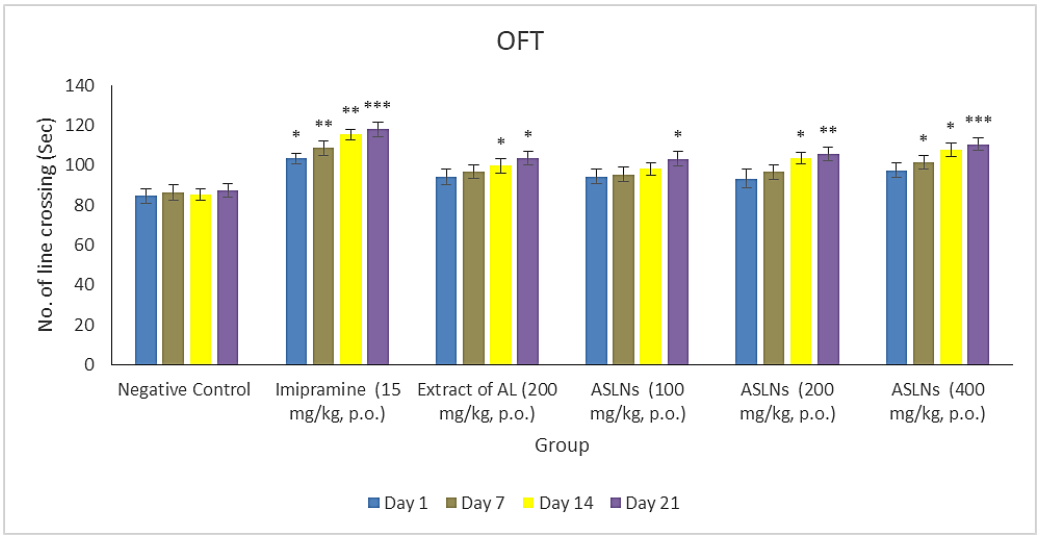

Figure 4: Effect of drugs on open field test.

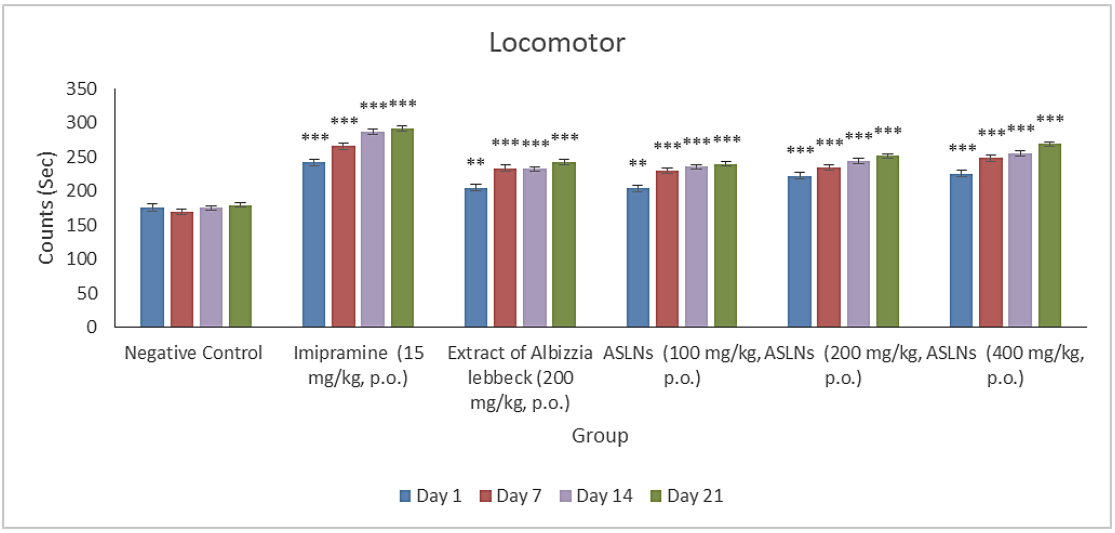

Figure 5: Effect of drugs on locomotor activity.

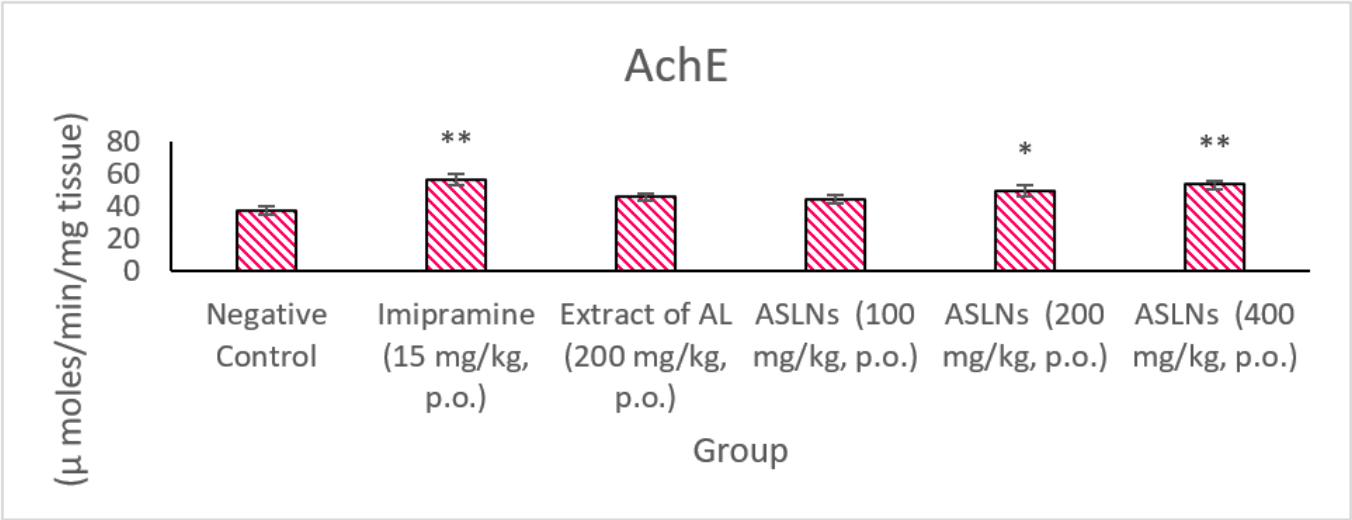

Figure 6: Effect of drugs on acetylcholinesterase enzyme in rat brain sample.

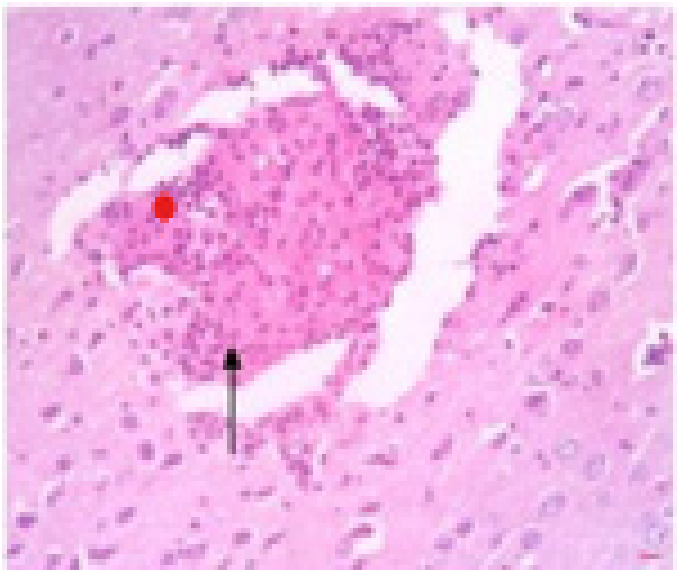

Figure 7: Histological exam forALSNs.

Table 6: Effect of drugs on acetylcholinesterase enzyme in rat brain.

Group	Treatment	AchE (µ moles/min/mg tissue)
I	Control receives vehicle	37.07±2.56
II	Imipramine (15 mg/kg, p.o.)	56.43±3.25**
III	Extract of *Albizzia lebbeck* (200 mg/kg, p.o.)	45.87±2.30
IV	ASLNs (100 mg/kg, p.o.)	44.38±2.46
V	ASLNs (200 mg/kg, p.o.)	49.57±3.67*
VI	ASLNs (400 mg/kg, p.o.)	53.28±2.70**

All the values were expressed in Mean±SEM (n=6). The statistical analysis was carried out using one way ANOVA. Significant after Analysis of Variance (ANOVA) followed by Dunnett test. *$p<0.5$, when compared to control group.

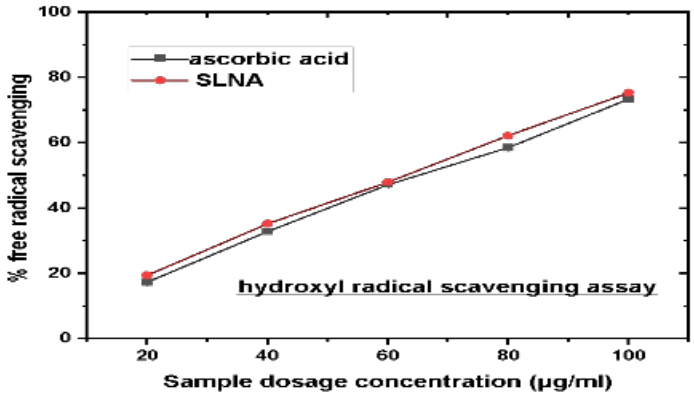

Figure 8: Hydroxyl radical scavenging assay.

CONCLUSION

In Swiss albino mice, *Albizia lebbeck* Solid Lipid Nanoparticles (ASLNs) significantly reduced depression in all groups in a dose-dependent manner. These results imply that ASLNs have significant antidepressant qualities. To support possible future applications in humans, more research is needed to identify the active ingredients and clarify the underlying molecular mechanisms.

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ABBREVIATIONS

TST: Tail suspension test; **OFT:** Open field test; **ACE:** Acetylcholinesterase; **SDA:** Superoxide dismutase activity; **GSH:** Glutathione content; **CAT:** Catalase.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The protocol was approved by IAEC, Shri Adichunchanagiri College of Pharmacy, B G Nagara-571448(IAEC) registered with the CPCSEA guidelines (377/PO/ReBi/S/2001/CPCSEA dated 01-10-2024).

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