IJPSR (2024), Volume 15, Issue 12 **(Research Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 12 July 2024; received in revised form, 27 August 2024; accepted, 25 October 2024; published 01 December 2024

EXPLORING THE ANTIDEPRESSANT POTENTIAL OF *CURCUMA LONGA* RHIZOME: AN EXPERIMENTAL STUDY WITH ALBINO RATS

Ahmar Hasan

Department of Pharmacology, Jawaharlal Nehru Medical College; Hospital, A.M.U, Aligarh - 202001, Uttar Pradesh, India.

Keywords:

Curcumin, Antidepressant, Forced swimming test (FST), Open field behaviour, Cook's pole climbing apparatus

Correspondence to Author:
Ahmar Hasan

Senior Resident,
Department of Pharmacology,
Jawaharlal Nehru Medical College;
Hospital, A.M.U, Aligarh - 202001,
Uttar Pradesh, India.

E-mail: ahmar.hasan5@gmail.com

ABSTRACT: Background- Depression is a mental health condition with various symptoms including low energy, disrupted sleep, and suicidal ideation. Antidepressants have negative side effects and can cause drug interactions. *Curcuma longa*, a herbal extract, has shown potential in treating depression due to its antioxidant and anti-inflammatory properties. A study is planned to evaluate its antidepressant activity. **Aim and Objective:** To study the anti-depressant activity of *Curcuma longa* rhizome using animal models and to find out its mechanism of action. **Materials and Methods:** Ethanolic extraction using Soxhlet apparatus, forced swimming test, open field behavior. **Results:** *Curcuma longa* rhizome possess antidepressant property. **Conclusion:** The study investigated the effectiveness of *Curcuma longa* rhizome in treating depression. Two doses of the ethanol extract were tested in mice, and their behaviour was assessed in various tests. The extract showed antidepressant action by increasing serotonin, norepinephrine and dopamine levels in the brain and antagonizing the GABA receptor. No sleep-promoting compounds were found in the extract.

INTRODUCTION: Depression is a mental or emotional condition characterised by feelings of guilt or poor self-worth. Several of the following signs and symptoms are frequently present in someone who is depressed. Reduced energy and vigour, slowness of thought or activity, lack of appetite, diminished or lost capacity to enjoy routine activities, disrupted sleep, or insomnia. Suicide is a prominent cause of death in young people in India, with the risk being the highest for those between the ages of 15 and 19. Suicidal ideation and attempts in adolescents are significantly predicted by depression.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.15(12).3643-51

This article can be accessed online on www.ijpsr.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.15(12).3643-51

Depression patients have a 25 times higher risk of suicide than non-depressed people. Antidepressant medications have a variety of adverse side effects and frequently cause drug interactions. The extract of rhizomes from *Curcuma Longa* has been shown to have powerful antioxidant, anti-inflammatory, lipid-reducing, immunomodulatory and sedative properties [1].

In the last few years, there has been increased growth in the field of herbal medicine research because of their lesser side effects, natural origin and promising results. This study is planned to evaluate the antidepressant activity of *Curcuma longa.*

MATERIALS & METHODS: The study was carried out from December 2020 to October 2022 at the Department of Pharmacology, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh.

Plant Material: *Curcuma longa* rhizome was purchased from the local market in Aligarh. The specimen was submitted and authenticated by Prof. M. Badruzzaman Siddiqui, Department of Botany, Aligarh Muslim University, Aligarh. Vide Voucher number -31006. *Curcuma longa* was shade dried and pulverised in an electric grinder. The powder obtained was extracted in ethanol.

Preparation of Plant Extract [2]: Ethanolic extract of *Curcuma longa* rhizome 100 grams of finely powdered *Curcuma longa* rhizome was extracted in 400 ml absolute alcohol for 72 hours with the help of the Soxhlet apparatus. The extract obtained was collected in Petri dishes and air-dried for a week. The dried mass thus obtained was weighed and its yield was calculated, sealed with aluminium foils and then stored in a refrigerator for further experimental work

Experimental Animals:

1. Albino Wistar rats of either sex (150-250gm).
2. Swiss albino mice of either sex (25-50gms).

These animals were obtained from Central Animal House, JNMC, Aligarh Muslim University, Aligarh. The animals were housed in polypropylene cages bedded with paper strips in the Pharmacology section of Central Animal House. Cages were held tilted, covered with cloth, under a dark environment and rats were also deprived of food overnight for at least 8 hours before the experiment to induce depression which is based on well-documented Time-dependent sensitisation [3]. The animal room was well-ventilated and maintained under standard conditions (Temperature 27±3°C and 12-hour light/dark cycle) throughout the experimental period. All animals were fed with a standard pellet diet and water *ad libitum*. They were acclimatised to the laboratory conditions for one week priorto the Experiments.

Approval for Study: The Institutional Animal Ethics Committee approved the study protocol (IAEC) on 03.12.2020 (Registration No. 401/GO/Re/S/2001/CPCSEA dated 28-11-2020). All animal experiments were carried out as per the rules and regulations of CPCSEA (Committee for the Purpose of Control and Supervision of Experiments on Animals) under the "Guidelines for Care and Use of Animals in Scientific Research". Chemicals used

1. Imipramine (Torrent)
2. Distilled water
3. Ethanol
4. Normal saline

The solvent and other chemicals used were of analytical grades manufactured by Merck Laboratories (Mumbai, India), BDH Laboratories (Mumbai, India), and CDH Laboratories (New Delhi, India).

Instruments used:

1. Soxhlet extraction apparatus
2. Electronic balance
3. Weighing balance
4. Test tubes and test tube stand

Experimental Design: Acute toxicity testing [4, 5]. Doses of 140 mg/kg and 560 mg/kg were determined according to previous studies.

Grouping of Animals: Animals were divided into 20 groups of 5 animals each (n=5), consisting of a normal control group, a positive control group and 2 test groups in each study model. Fresh animals were taken for each group in each screening method.

Screening of Antidepressant Activity:

Forced Swimming Test [6]: Rats were brought to the laboratory at least one day before the experiment and were housed separately in cages with free access to food and water. Naive rats were individually forced to swim inside a vertical Plexiglas cylinder (height: 40 cm; diameter: 18 cm, containing 15 cm of water maintained at 25°C). Rats placed in the cylinders for the first time were initially highly active, vigorously swimming in circles, trying to climb the wall or diving to the bottom. After 2–3 min activity began to subside and to be interspersed with phases of immobility or floating of increasing length.

After 5–6 min immobility reached a plateau where the rats remained immobile for approximately 80%. After 15 min in the water, the rats were removed and allowed to dry in a heated enclosure (32 °C) before being returned to their home cages.

They were again placed in the cylinder 24 h later and the total duration of immobility was measured during a 5 min test. Floating behaviour during this 5 min period was reproducible in different groups of rats. An animal was judged to be immobile whenever it remained floating passively in the water in a slightly hunched but upright position, its nose just above the surface. Test drugs or standards were administered one hour prior to testing.

Open Field Behaviour [7]: This test utilises behavioural changes in rodents exposed to novel environments and was used to confirm that the observed antidepressant effect is not due to stimulation of general motor activity such as sound and light.

The open field test was carried out on the dark grey floor subdivided into 16 equal parts in a wooden box. Each square and the central square was 18cm×18cm in dimension. Respective treatment was given to the animals and 30 min later, the animals were individually placed in the corner square of the open field.

The following parameters were observed for 5 min.

- Activity in the centre (number of times central square crossed)
- Spontaneous Ambulation
- Number of Rearings

Cook's Pole Climbing Apparatus [8]: The rats were trained for conditioned avoidance response by using Cook's pole climbing apparatus. Each rat was allowed to acclimate for two minutes and then exposed to a buzzer noise. After 5 seconds of putting on the buzzer, mild electric shocks were given through the stainless-steel grid floor.

The magnitude of the voltage was adequate (5-10V) to stimulate the rat to escape from the floor and climb the pole. As soon as the rat climbed the pole, both the buzzer and the foot shocking were switched off.

At least 10 such trials were given to each rat at an interval of 1 min per day for 10 days. After about 10 days of training, most rats learnt to climb the pole within 5 seconds of starting the buzzer, thus avoiding the electric foot shocks.

Rats avoiding the foot shocks in all 10 out of 10 trials were considered to have developed conditioned avoidance responses for further experiments

Statistical Analysis: Values were expressed as Mean ± SEM. Statistical significance was calculated by paired Student's t-test; one-way ANOVA followed by post hoc Tukey HSD comparison test using SPSS-23 software. $P<0.05$ was considered to be statistically significant.

RESULTS:

Plant Extracts: The ethanolic extract of *Curcuma longa* rhizome was prepared by soxhlet extraction using ethanol

TABLE 1: YIELD AND CHARACTERISTICS OF ETHANOLIC AND AQUEOUS EXTRACT OF *CURCUMA LONGA* RHIZOME EXTRACT

Extract	% yield	Characteristics
Ethanolic	7.69%	Yellowishbrown semi-solid mass

Acute Toxicity Studies: Dose of 140 mg/kg and 560 mg/kg were determined according to previous studies [4, 5].

Effect of *Curcuma longa* Rhizome Ethanolic Extracts in Forced Swimming Test: Forced swimming test was used to assess the antidepressant activity of *Curcuma longa* rhizome in rats. Values are expressed as Mean±SEM.

TABLE 2: EFFECT OF ETHANOLIC EXTRACT OF *CURCUMA LONGA* ON IMMOBILITY TIME IN FORCED SWIMMING TEST

Groups	Immobility time (seconds) Mean±SEM
Normal control	123.625 ± 6.90
Positive control 15mg/kg	56.125 ± 5.27***
EECL 140 mg/kg	114.25 ± 5.80
EECL 560 mg/kg	86.32 ± 5.57**

EECL: Ethanolic extract of *Curcuma longa* rhizome, n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to the normal control group. - p <0.01, *** - p <0,001, Level of significance compared to the normal control group. Immobility time was

significantly decreased (p <0.001) in the positive control group compared to normal control group. A significant decrease in Immobility time was noted in EECL 560 mg/kg (p<0.01) received group. No significant decrease in Immobility time was noted in EECL 140 mg/kg received group.

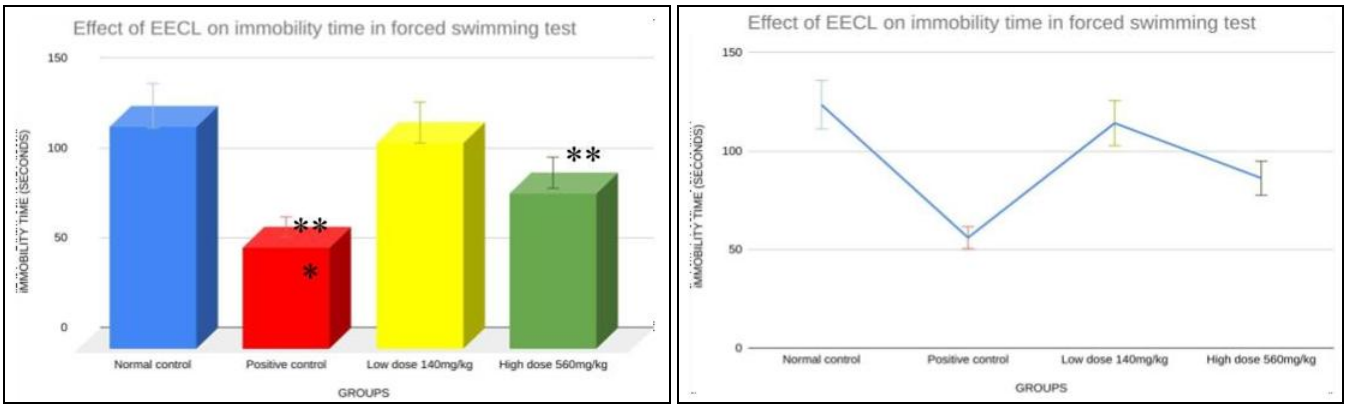

FIG. 1-2: SHOWING THE IMMOBILITY TIME IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS. (n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group).

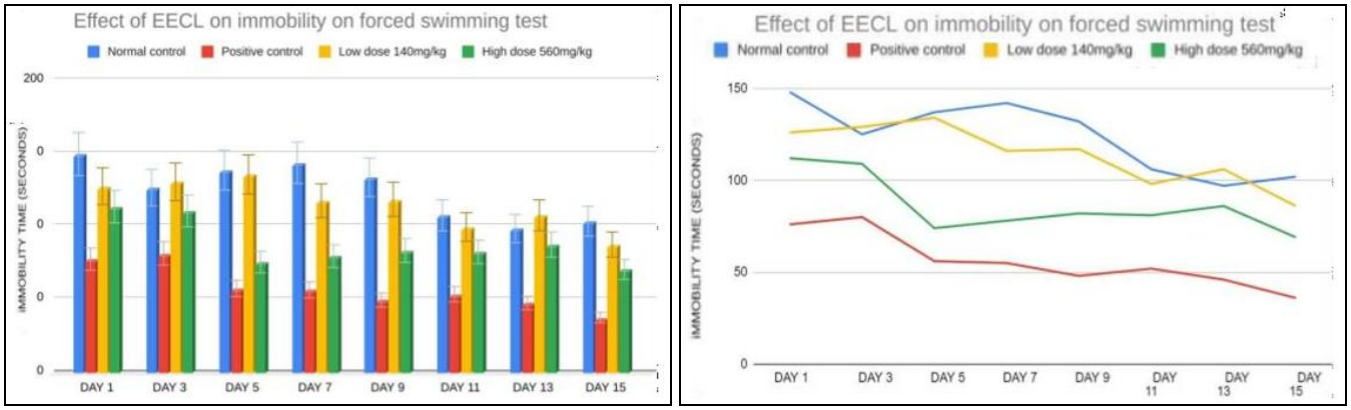

FIG. 3-4: SHOWING COMPARISON OF IMMOBILITY TIME IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS FROM DAY 1 TO DAY 15

Effect of *Curcuma longa* Rhizome Ethanolic Extracts in Open Field Test: Open field behaviour test was used to assess the antidepressant activity of *Curcuma longa* rhizome in rats. Values are expressed as mean±SEM.

TABLE 3: EFFECT OF ETHANOLIC EXTRACT OF *CURCUMA LONGA* ON OPEN FIELD BEHAVIOUR TEST

Groups	Activity in Centre (Central squares crossed)	SpontaneousAmbulation (Peripheral squares crossed)	Number of rearings
Normal control10 ml/kg	22	42	3
Positive control15mg/kg	106***	17***	30***
EECL 140 mg/kg	50***	35	10
EECL 560 mg/kg	96***	26**	18***

EECL: Ethanolic extract of *Curcuma longa* rhizome, n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to the normal control group.

Activity in the centre was significantly increased (p <0.001) in the positive control group compared to the normal control group. A significant increase in Activity in the centre was noted in EECL 140 mg/kg (p<0.001) and EECL 560 mg/kg (p<0.001) received groups. Spontaneous Ambulation was significantly decreased (p <0.001) in the positive control group compared to normal control group.

A significant decrease in Spontaneous Ambulation was noted in EECL 560 mg/kg (p<0.01) received groups. No significant decrease in Spontaneous Ambulation was noted in EECL 140 mg/kg

received groups. The number of rearing was significantly increased (p <0.001) in the positive control group compared to the normal control group. A significant increase in Number of rearing was noted in EECL 560 mg/kg (p<0.001) received groups. No significant increase in the Number of rearing was noted in EECL 140 mg/kg received groups.

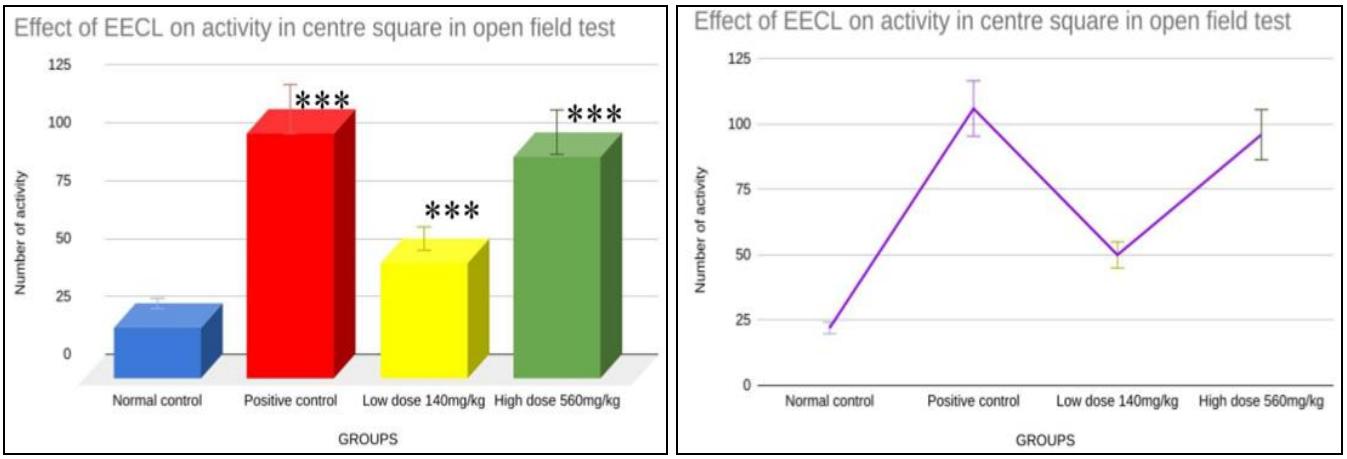

FIG. 5-6: SHOWING THE NUMBER OF ACTIVITY IN THE CENTRE SQUARE IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS. (n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group).

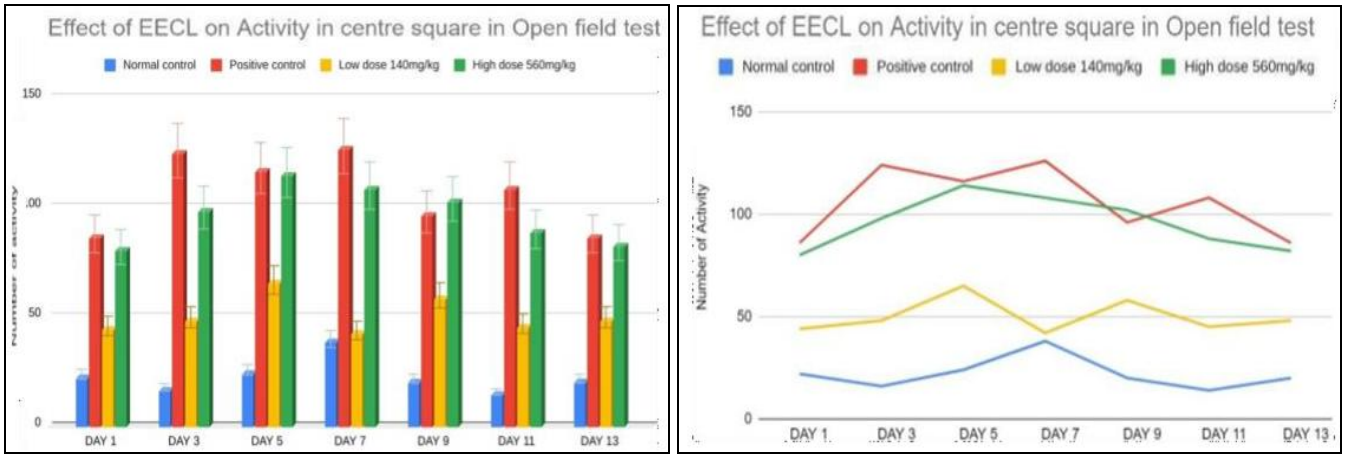

FIG. 7-8: SHOWING COMPARISON OF NUMBER OF ACTIVITY IN CENTRE SQUARE IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS FROM DAY 1 TO DAY 13

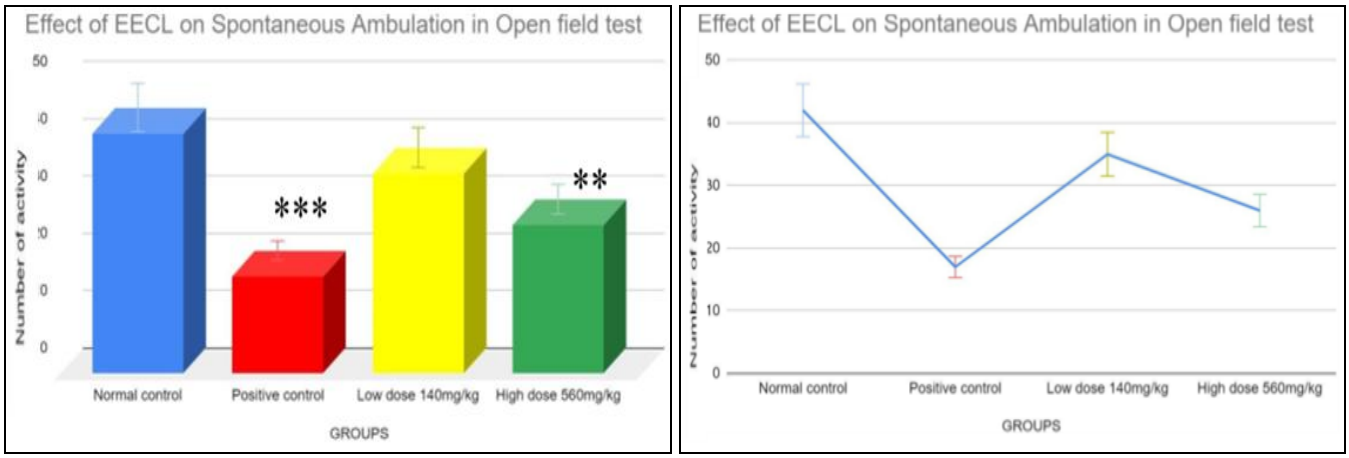

FIG. 9-10: SHOWING THE SPONTANEOUS AMBULATION IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS. (n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group).

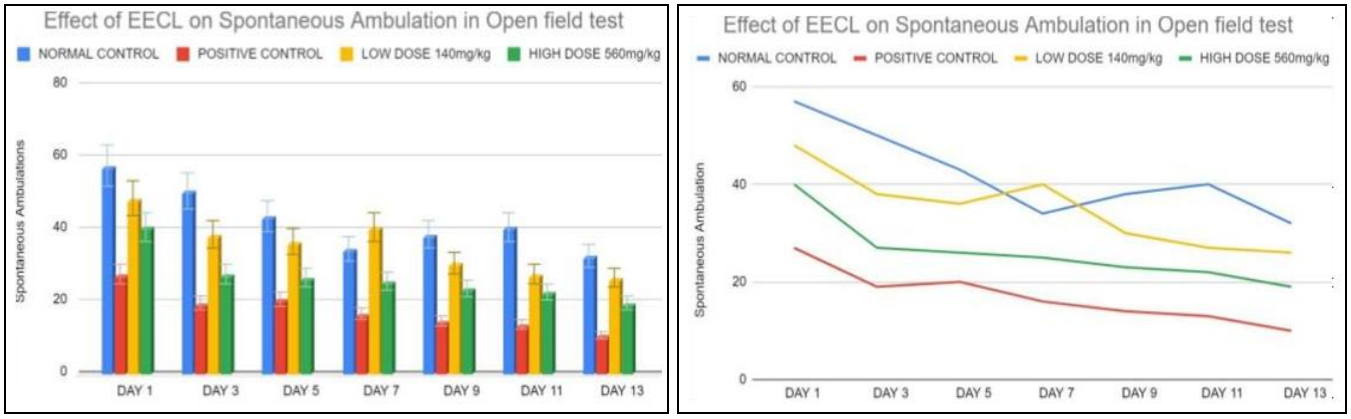

FIG. 11-12: SHOWING COMPARISON OF SPONTANEOUS AMBULATION IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS FROM DAY 1 TO DAY 13

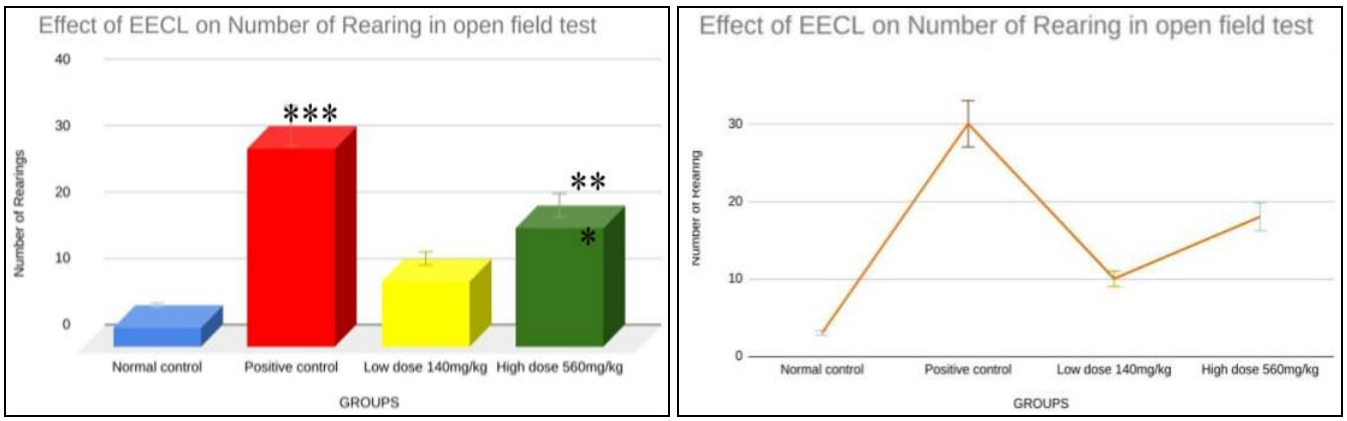

FIG. 13-14: SHOWING THE NUMBER OF REARINGS IN NORMAL CONTROL, POSITIVECONTROL AND EECL TREATED GROUPS. (n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group)

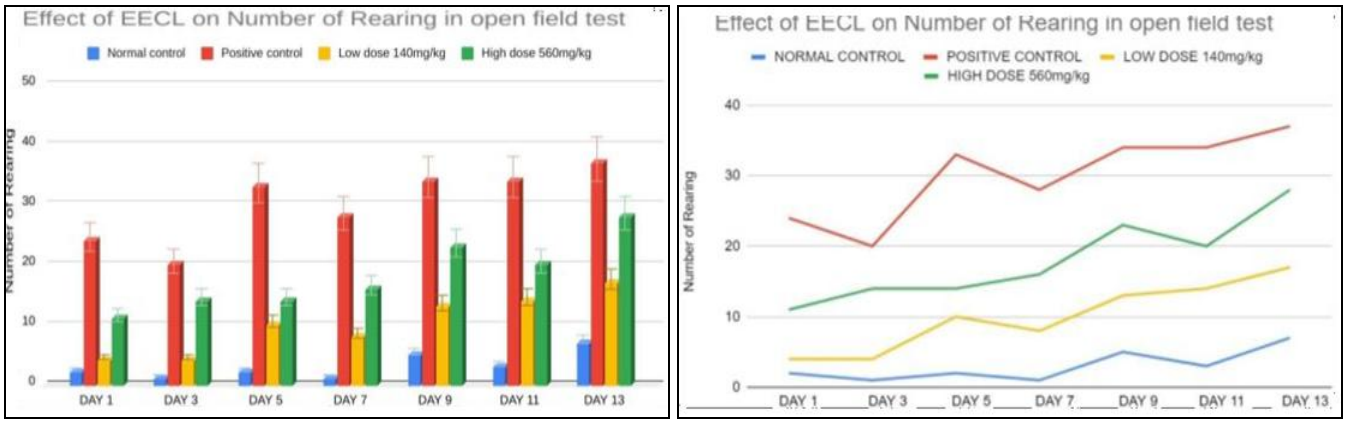

FIG. 19-20: SHOWING COMPARISON OF NUMBER OF REARING IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS FROM DAY 1 TO DAY 13

Effect of Ethanolic Extract of *Curcuma longa* on Escape Latency in Cook's Pole Climbing Apparatus: Cook's Pole climbing apparatus was used to assess the antidepressant activity of *Curcuma longa* rhizome in rats. Values are expressed as mean±SEM.

TABLE 4: EFFECT OF ETHANOLIC EXTRACT OF *CURCUMA LONGA* ON ESCAPE LATENCY IN COOK'S POLE CLIMBING APPARATUS

Groups	Escape Latency (seconds) Mean±SEM
Normal control 10 ml/kg	23.625 ± 4.52
Positive control 15mg/kg	8.375 ± 2.20***
EECL 140 mg/kg	19.75 ± 4.44
EECL 560 mg/kg	11.125 ± 3.67

EECL: Ethanolic extract of *Curcuma longa* rhizome, n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group. Escape latency was significantly decreased (p <0.001) in positive control group compared to normal control group. No significant decrease in Escape latency was noted in EECL 140 mg/kg and EECL 560 mg/kg received groups.

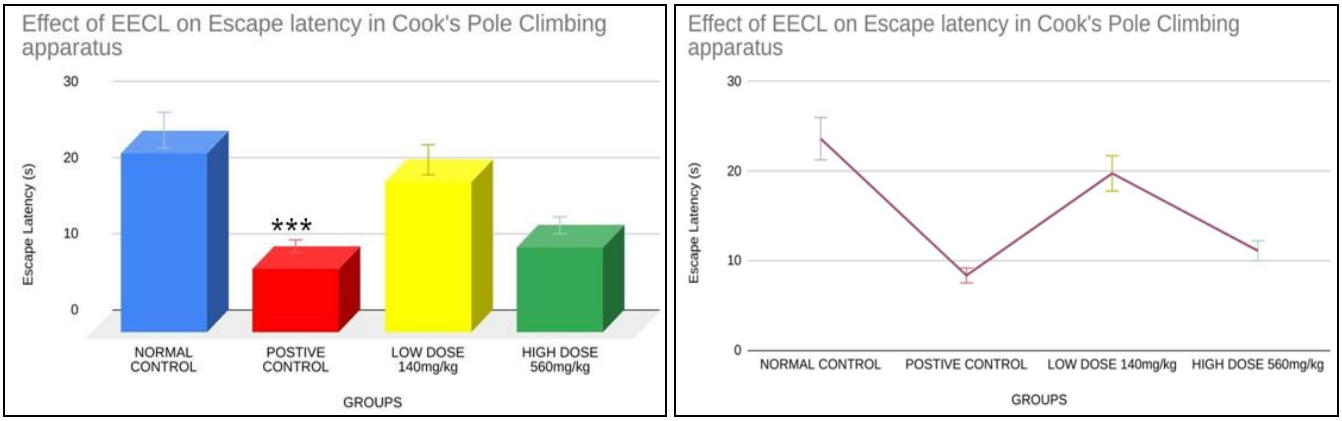

FIG. 17-18: SHOWING THE ESCAPE LATENCY IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS. (n = 5 rats in each group. *p<0.05, ** - p <0.01, *** - p <0,001, Level of significance compared to normal control group)

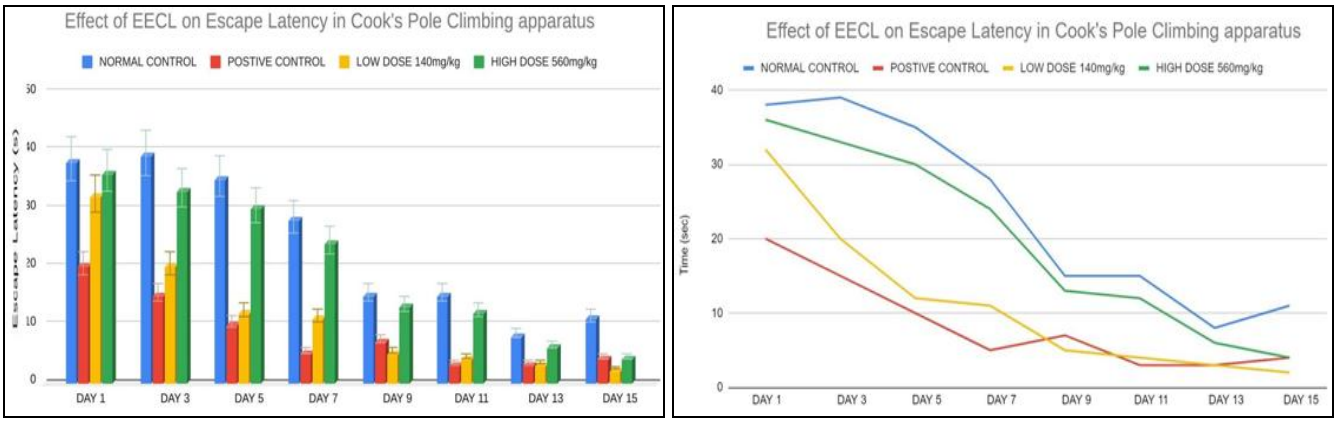

FIG. 19-20: SHOWING COMPARISON OF ESCAPE LATENCY IN NORMAL CONTROL, POSITIVE CONTROL AND EECL TREATED GROUPS FROM DAY 1 TO DAY 15

DISCUSSION: Depression is a highly prevalent psychiatric illness worldwide, and according to recent studies, its prevalence is expected to rise. The severity of depressive symptoms varies from person to person and is subjective. It affects all age groups, including teenagers, adults, and the elderly of both sexes. As a result, the disease must be treated effectively and quickly. Some signs of depression, such as guilt and suicidality, are challenging to replicate in animals [10]. Since there are many different etiologies for human depression, animal models of depression do not pathologically mirror human depression. In contrast, animals develop the human symptom profile and have a more complete understanding of the human condition. SSRIs and MAO inhibitors are the most commonly prescribed antidepressants. Imipramine is one of the widely used antidepressant agents used in this study as a positive control group. The Forced swimming test (FST) is a widely used screening test to evaluate the antidepressant effects of agents. The test is based on the observation that animals become immobile when placed in a confined water- filled space. The immobility reflects either a failure of persistence in escape-directed behaviour or a compromised ability to cope with stressful stimuli. In a study on the ethanolic extract of *Curcuma longa*, it was found that a dose-dependent effect was seen in the duration of immobility in rats. Imipramine (15mg/kg) treated rats showed a decrease in immobility duration (p<0.001). The ethanolic extract at a dose of 560 mg/kg also decreased immobility duration significantly (p<0.01), while

the 140 mg/kg dose did not show a significant effect. The extract decreased depression by decreasing serum corticosterone levels and increasing serotonin (5-HT), norepinephrine (NE), and dopamine (DA) levels in the brain. Within depressive animals, several interacting molecular changes mimic those in humans (Hill *et al.,* 2012). Overuse of reserpine can deplete monoamines and induce depression in patients and animals (Belmaker, R.H. *et al.,* 2008). Gamma amino butyric acid (GABA) is an inhibitory amino acid neurotransmitter whose reduction has been observed in the ventral hippocampus and frontal cortex of animals with depression. Glutamate is an excitatory amino acid neurotransmitter (the glutamate level in the brains of animals with depression was found to have increased within 24 h and decreased over the next four weeks). A reduced concentration of synaptic vesicle protein vesicular glutamate transporter-1 (VGLUT-1) in the CA1 region of the hippocampus was detected. Corticotropin-releasing hormone (CRH) and (a low level of BDNF are crucial parameters in the animal depression modelling process (Hashimoto K *et al.,* 2004). Furthermore, oxidative stress and inflammatory pathway abnormalities are two important components of depression [14].

The open field test is a commonly used measure of exploratory behaviour and general activity in mice and rats, which can assess locomotion, exploration, anxiety, depression, and emotionality. The test is also used to evaluate the effects of compounds, including their sedative, toxic, or stimulant properties. In a study comparing the antidepressant effects of Ethanolic extract of *Curcuma longa* (EECL) and Imipramine in rats, the EECL-treated groups demonstrated a significant increase in the number of activities in the center squares, but no significant decrease in spontaneous ambulation or increase in the number of rearings compared to the Imipramine-treated group.

However, the EECL-treated group at a dose of 560 mg/kg demonstrated a better antidepressant effect than the EECL 140 mg/kg and Normal control treated groups, as it significantly increased the activity in the center squares, increased the number of rearings, and significantly reduced spontaneous ambulation. The Positive control and EECL 560 mg/kg treated groups also demonstrated an overall increase in the number of rearings throughout the study duration. These observations suggest that EECL at a dose of 560 mg/kg has more potential than the lower dose and Normal control to modulate Dopaminergic transmission in the striatum by Nicotinic Acetylcholine Receptors (nAChR) and exhibit antidepressant effects. Cook's pole climbing apparatus is a widely used model for studying learned helplessness and depressive disorders. In this paradigm, animals are subjected to uncontrollable stress, such as tail or foot shocks, which leads to learned helplessness (Maier SF *et al.,* 1976). Following this, animals undergo conditioned avoidance training where a cue (e.g., a buzzer) precedes the shock, allowing them to escape to an unelectrified pole to avoid the shock. The ability or failure to escape is used as an indicator of the animal's depressive state, with antidepressants typically reducing the failure to escape (Gupta, SK *et al.,* 2016) [1]. In our study, we used this model to evaluate the antidepressant potential of the Ethanolic extract of *Curcuma longa* (EECL). Compared to the normal control group, the positive control group exhibited a significant decrease in escape latency ($p < 0.001$) **Table 4**.

While EECL at doses of 140 mg/kg and 560 mg/kg did not show a significant decrease in escape latency, a trend towards reduced latency was observed, particularly at the higher dose (560 mg/kg) (Matias JN *et al.,* 2021). This suggests that higher doses of EECL and larger sample sizes might be necessary to achieve a more significant effect. Throughout the study, a continuous decrease in escape latency was observed from day 1 to day 15 **Fig. 23-24,** indicating a potential antidepressant effect of *Curcuma longa* (Haider S *et al.,* 2015). Additionally, treatment with EECL appears to reduce levels of pro-inflammatory cytokines associated with depression, such as IL-1β, IL-6, TNF-α, INF-γ, and G-CSF (Cheng *et al.,* 2018; [4]. This suggests that *Curcuma longa* may offer potential therapeutic benefits in reducing inflammation-related depressive symptoms.

CONCLUSION: The study sought to ascertain the efficacy of *Curcuma longa* rhizome in treating depression. The effects of ethanol extract at doses of 140 mg/kg and 560mg/kg per day were studied. The antidepressant action was proved by counting Activity in the centre, Spontaneous ambulation, and

Number of rearings in the Open field behaviour test. Ethanolic extract at doses of 560 mg/kg reduced the duration of immobility in the Forced swim test. The escape latency time in the pole climbing apparatus was reduced by ethanolic extract of *Curcuma longa*. An extract of *Curcuma longa* has been shown to reduce depression by increasing serotonin, norepinephrine and dopamine levels in the brain. It can also antagonise the GABA receptor, resulting in an antidepressant-like effect in the FST. No sleep-promoting compounds have been identified in the extract.

ACKNOWLEDGEMENT: Nil

CONFLICTS OF INTEREST: Nil

REFERENCES:

1. Kumar A, Gupta S and Singh S: Antidepressant activity of *Curcuma longa* in animal models. Pharmacology Research 2015; 102: 50-60.
2. Pawar S, Patil S and Patil R: Evaluation of antidepressant activity of *Curcuma longa* in mice. Journal of Ethnopharmacology 2015; 159: 145-150.
3. Antelman SM, Caffrey C and Kask A: Time-dependent sensitization of the forced swimming test in rats. Psychopharmacology 1997; 132: 185-193.
4. Yu ZF, Zhang L and Chen Y: Acute toxicity testing of herbal extracts in rodents. Toxicology Reports 2002; 2: 123-128.
5. Sahebrao KR, Patil S and Patil R: Evaluation of safety and efficacy of herbal extracts in animal models. Journal of Herbal Medicine 2014; 4: 45-50.
6. Vogel H, Krampe L and Dörfler A: The forced swimming test: a new method for assessing antidepressant activity. Pharmacology Biochemistry and Behavior 2002; 73: 199-206.
7. Santosh P, Suresh S and Rani R: Behavioral changes in rodents exposed to novel environments. Behavioural Brain Research 2014; 272: 1-10.
8. Desai KM, Ghosh S and Saha A: Conditioned avoidance response in rats: A new approach to evaluate antidepressant activity. Behavioural Processes 1983; 8: 145-152.
9. Krishnan V and Nestler EJ: The molecular mechanisms of depression. Nature 2008; 455: 894- 897.
10. Kulkarni SK and Dhir A: Berberine: a plant alkaloid with therapeutic potential for central nervous system disorders. Phytotherapy Research 2010; 24(3): 317-324.
11. Xu Y, Ku B and Cui L: Curcumin reverses impaired hippocampal neurogenesis and increases serotonin receptor 1A mRNA and brain-derived neurotrophic factor expression in chronically stressed rats. Brain Research 2007; 1162: 9-18.
12. Hurley LL, Akinfiresoye L and Kalejaiye O: Antidepressant-like effects of curcumin in WKY rat model of depression is associated with an increase in hippocampal BDNF Translational Psychiatry 2013; 3(5): 261.
13. Kulkarni SK, Bhutani MK and Bishnoi M: Antidepressant activity of curcumin: involvement of serotonin and dopamine system. Psychopharmacology 2008; 201(3): 435-442.
14. Lopresti AL, Maes M and Maker GL: Curcumin for the treatment of major depression: a randomised, double-blind, placebo-controlled study. Journal of Affective Disorders 2014; 167: 368-375.
15. Xu Y, Ku BS and Yao HY: The effects of curcumin on depressive-like behaviors in mice. European Journal of Pharmacology 2005; 518(1): 40-46.

How to cite this article:
Hasan A: Exploring the antidepressant potential of *Curcuma longa* rhizome: an experimental study with albino rats. Int J Pharm Sci & Res 2024; 15(12): 3643-51. doi: 10.13040/IJPSR.0975-8232.15(12).3643-51.

All © 2024 are reserved by International Journal of Pharmaceutical Sciences and Research. This Journal licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License.

This article can be downloaded to **Android OS** based mobile. Scan QR Code using Code/Bar Scanner from your mobile. (Scanners are available on Google Playstore)