Sahel Journal of Life Sciences FUDMA (SAJOLS)
June 2026 Vol. 4(2): 613-620
ISSN: 3027-0456 (Print)
ISSN: 1595-5915 (Online)
DOI: https://doi.org/10.33003/sajols-2026-0403-65

Research Article

Therapeutic Potential of *Bombax buonopozense* (Bombaceae) Against Neurostimulants-Induced Psychotic Symptoms in Murine

***Yusuf Alkali Ibrahim[1] and Aminu Ahmed Biambo[2]**

[1]Department of Pharmacology and Toxicology Usmanu Danfodiyo University Sokoto, Nigeria
[2]Department of Clinical Pharmacy and Pharmacy Practice Usmanu Dafodiyo University Sokoto, Nigeria
****Corresponding Author's email*: yusuf.alkali@udusok.edu.ng; Phone: +2348069048356**

ABSTRACT
Psychosis pose an imminent threat to human society as most of its symptoms are not resolve by current conventional agents, hence the need to explore the neurobiology of the disease and uncover other pathways that are implicated in the disease. The aim of this study was to evaluate the therapeutic potential of methanol leaf extract of *Bombax buonopozense* in laboratory animals. The plant material was subjected to maceration extraction, phytochemical and elemental analysis was performed on the extract using Trease and Evans protocol.. Animal test models such as open field test, forced-swim test, novel object recognition test, Y-maze test, elevated plus maze, psilocybin-induced hyperactivity and haloperidol-induced catalepsy were employed and every test in a specific pathway involved use of 36 mice divided into six groups of 6. Each mice were treated with distilled water as control and group 2, 3 and 4 were treated with 100, 200 and 400 mg of the extract while group 5 was treated with 1 mg/kg risperidone as the positive control and group six are normal untreated control. The extract revealed some phytochemicals such as alkaloid, flavonoid among others. Post neuro-stimulants induction, the extract across the doses significantly ($p<0.05$) decreases the symptoms of psychosis in mice compared with distilled water treated group in all the behavioral models employed targeting the serotonergic, dopaminergic and glutamatergic pathways of psychosis. It can be concluded that, *Bombax buonopozense* extract contained phytochemicals that elicit therapeutic effects against neuro-stimulants induced psychotic symptoms in murine model.

Keywords: *Bombax buonopozense;* Cognitive symptoms; Neuro-stimulants; Neurobehavioral; Psychosis; Therapeutic effect

Citation: Ibrahim, Y.A., & Biambo, A.A. (2026). Therapeutic Potential of *Bombax buonopozense* (Bombaceae) Against Neurostimulants-Induced Psychotic Symptoms in Murine. *Sahel Journal of Life Sciences FUDMA*, 4(2): 613-620. DOI: https://doi.org/10.33003/sajols-2026-0403-65

INTRODUCTION

Brain function is the single most important aspect of physiology that defines the difference between humans and other species. The cerebrum is connected by the brainstem to the spinal cord. Neurons connect to form neural pathways, neural circuits, and elaborate network systems. The whole circuitry is driven by the process of neurotransmission (Molina *et al.,* 2015*)*. Pathological conditions of the brain are eminent threat to human society; hence they create an avenue for prompt research (Rang *et al.,* 2016). Psychotic symptoms are grouped into about five categories, but due to certain overlaps in some symptomatic presentation, three categories are more popularly reported. These are positive symptoms (auditory and visual hallucinations, delusions, conceptual disorganization and thought disorder, negative symptoms emotional blunting, social withdrawal, anhedonia, avolition, poverty of thought and content of speech and cognitive symptoms (including impaired executive function, memory and attention (Selemen, 2015). Many patients undergo prolonged periods of remission interspersed with relapses of psychotic episodes.

Disease onset is typically post adolescence (16–25 years), with a higher incidence of psychotic symptoms in males and a bimodal later onset (40–60 years) in females. Although the etiology of schizophrenia remains contentious, it is a multifactorial neurodevelopmental disorder influenced by both genetic and environmental factors (Lewis and Lieberman, 2000), such that monozygotic siblings of affected individuals show a 50–80% risk of developing the disorder.

Psychosis is a chronic debilitating psychiatric disorder affecting 1% of the population worldwide (WHO, 2022). Drugs prescribed for the treatment of psychosis can be categorized as typical and atypical. Regular intake of these agents may also increase oxidative load and thereby further enhance the progression of the disease (Meltzer, 2010; Meyer, 2011). In a scenario like this we need drugs with lesser side effects. In recent years research interest and activities to validate and document herbals have increased tremendously due to lesser side effect. Since psychiatric disorders are on rise, clinicians are looking for alternative therapies and also trying to exploit herbal medications for the treatment of neuropsychiatric disorders. Simultaneously, this revival of interest in herbal medicines is supported by the explosion of the ethnomedicine literature and by an increased awareness of people and the recognition of natural medicines globally (Van *et al.,* 2010). Besides possessing fewer adverse effect, natural products structurally possess broad spectrum chemical diversity, biochemical specificity and other medicinal properties that also make them favourable as lead structures for the remedies of a number of disorders including psychosis. Therefore, we have directed our endeavors towards establishing the scientific rational in governing the efficacy of *Bombax buonopozense* for its potential to treat psychotic symptoms. *Bombax buonopozense* is a large tropical tree that grows up to 40 m in height with large buttress roots that can spread up to 6 m. Some uses of *B. buonopozense* include anxiolytic and antidepressant effect and other traditionally reported central nervous system effects such as insanity treatment prompted our attention to hypothesized that, it may be beneficial for psychosis. Efforts will also be exhibited to find its underlying mechanism of action in this disorder.

MATERIALS AND METHODS

Extraction and Preparation of the Plant Extract

The plant leaf was dried under shade with intermittent weighing until constant weight was obtained and then size-reduced using mortar and pestle. The powdered plant material was subjected to extraction using methanol by maceration method. The methanol extract was concentrated under reduced pressure and temperature (40ºC). Thereafter, the extract was stored in desiccators until required for further studies.

Phytochemical Screening

Preliminary phytochemical screening was carried out on the methanol extract using standard procedures as described by Trease and Evans (2002).

Test for alkaloids

Wagner's test: Few drops of Wagner's reagent was added to a portion of the extract, a whitish precipitate indicated the presence of alkaloids.

Dragendroffs test: To the first test tube, few drops of freshly prepared Dragendroff's reagent was added and observed for formation of an orange to brownish precipitate which indicated alkaloid

Test for flavonoids

Shinoda's test: A portion of the extract was dissolved in 1-2 ml of 50% methanol in the heat. Metallic magnesium chips and few drops of concentrated hydrochloric acid were added. Appearance of red colour indicated the presence of flavonoids.

Test for saponins

About 10 ml of distilled water was added to a portion of the extract and it was shaken vigorously for about 30 seconds. The tube was allowed to stand in a vertical position and observed for 30 minutes. A honey comb froth that persists for 10-15 minutes indicates the presence of saponins.

Test for tannins

Ferric-chloride test: - To a portion of the extract, 3-5 drops of ferric-chloride were added. A greenish black precipitate indicates the presence of condensed tannins while hydrolysable tannins displayed blue or brownish-blue precipitate.

Test for anthraquinones

Bontrager's test: To a portion of the extract in a dry test tube, 5 ml of chloroform was added and shaken for at least 5 minutes. This was then filtered and the filtrate shaken with equal volume of 10% ammonia solution; bright pink colour in the aqueous (upper) layer indicates the presence of free anthraquinones.

Test for glycosides

To a portion of the extract, 5 ml of dilute sulphuric acid was added and boiled on a water bath for 10-15 minutes. This was then cooled and neutralized with 20% KOH. The solution was divided into two portions; to the first portion, 5 ml of a mixture of Fehling's solution A and B was added and boiled; a brick red precipitate indicate the release of reducing sugar as a

result of hydrolysis of glycoside. To the second portion, about 3 ml of ferric chloride solution was added; a green to blue colour inferred the release of phenolic aglycones due to hydrolysis.

Test for cardiac glycosides

Keller-Killiani's test: Glacial acetic acid (1 ml) was added to about 3mls of the solution which contained 2 mg of extract in a test tube hole at 45^0C; then two drops of concentrated H_2SO_4 was added along the side of the test tube. Formation of purple ring colour at the interface was observed for the presence of cardiac glycosides.

Test for steroids and triterpenes

Lieberman Bucchard's test: To 0.5 ml of the extract, equal volume of acetic acid anhydride was added and mixed gently. Then 1 ml of concentrated sulphuric acid was added down the side of the test tube to form a lower layer, colour changes were observed immediately and over a period of one hour. Blue to blue-green colour in the upper layer and a reddish pink or purple colour indicated the presence of steroids and triterpenes respectively.

Elemental analysis (X-Ray fluorescence)

The plant sample was crushed using Mixer/Mill (8000M) SPEX sample preparation machine for 5 minutes. The powder was transferred into a pellet preparation sample holder and compressed using hydraulic press at 35 Mega Pascal.

Psilocybin induced hyperactivity in open field test

Thirty-six mice were randomly grouped into six groups, doses of 100, 200 and 400 mg/kg extract were administered to group 2, 3 and 4 respectively, while group 1 and 5 received distilled water 10 ml/kg and 1 mg/kg risperidone respectively, group 6 was treatment naïve. The above treatments were done one hour prior to administration of 20 mg/kg psilocybin. Thirty minutes post psilocybin treatment each group was subjected to open field test and hyperlocomotion was observed for five minutes by each mouse.

MK 801-induced immobility in forced swim test

Thirty-six mice were divided into 6 groups, doses of 100, 200 and 400 mg/kg extract were administered to group 2, 3 and 4 respectively, while group 1 and 5 received distilled water 10 ml/kg and 1 mg/kg risperidone respectively, group 6 was treatment naïve. The above treatments were done one hour prior to administration of 100 mg/kg MK 801. Immobility was observed for four minutes by each mouse (Porsollt *et al.,* 1977).

MK 801-induced cognitive deficit in Novel object recognition test

The method described by Amann *et al*. (2010) was adopted. Thirty-six mice were randomly divided into 6 groups, doses of 100, 200 and 400 mg/kg extract were administered to group 2, 3 and 4 respectively, while group 1 and 5 received distilled water 10 ml/kg and 1 mg/kg risperidone respectively, group 6 is treatment naïve. The above treatments were done one hour prior to administration of 100 mg/kg MK 801. Thirty minutes post ketamine treatment each group was subjected to acquisition session with two identical objects in days one and one of the object is replaced with novel one and time of exploration each object was recorded.

MK 801-induced cognitive deficit in Y-maze

The method described by Akanmu *et al*. (2007) was adopted. Thirty-six mice were randomly divided into 6 groups, doses of 100, 200 and 400 mg/kg extract were administered to group 2, 3 and 4 respectively, while group 1 and 5 received distilled water 10 ml/kg and 1 mg/kg risperidone respectively, group 6 was treatment naïve. The above treatments were done one hour prior to administration of 100 mg/kg MK 801. Thirty minutes post MK 801 treatment each group was subjected to Y-maze test and alternations of A, B and C arms were recorded

Haloperidol induced catalepsy test

Thirty mice were grouped into five groups of six mice each were subjected to treatement as follows, group 1 received distilled water 10 ml/kg, group 2, 3 and 4 received 100, 200, and 400 mg/kg extract, then group 5 received 1 mg/kg risperidone 30 minutes prior to administration of haloperidol 5 mg/kg. Each animal was grasped gently and placed on the upper edge of the block. An animal will be considered cataleptic if it remains on the block for 60 s and duration was recorded

RESULTS

Phytochemical and Elemental Analysis

The phytochemical analysis revealed the presence of alkaloid, tannin, flavonoid, saponin, anthraquinone and steroids while elemental contents included zinc phosphorus, iron magnesium, alminium among others as displayed in Tables 1 and 2 below.

Effect of *Bombax buonopozense* extract on MK 801-Induced Hyperactivity in open field test

The extract of *Bombax buonopozense* significantly ($p<0.05$) decreased the number of square crossing both the central and peripheral across the doses of 100, 200 and 400 mg/kg (Table 3).

Effect of *Bombax buonopozense* extract on MK 801-Induced Hyperactivity in open field test

The extract of *Bombax buonopozense* significantly ($p<0.05$) increased the percentage recognition index across the doses of 100, 200 and 400 mg/kg (Table 4).

Effect of *Bombax buonopozense* extract on MK 801-Induced Spatial memory impairment in Y maze

The extract of *Bombax buonopozense* significantly ($p<0.05$) increased percentage spontaneous alternation across the doses of 100, 200 and 400 mg/kg (Table 5).

Effect of *Bombax buonopozense* extract on Psilocybin-Induced Hyperactivity in open field test

The extract of *Bombax buonopozense* significantly ($p<0.05$) decreased the number of square crossing both the central and peripheral across the doses of 100, 200 and 400 mg/kg (Table 6).

Effect of *Bombax buonopozense* extract on Haloperidol-Induced Catalepsy

The extract of *Bombax buonopozense* significantly ($p<0.05$) decreased the duration of catalepsy across the doses of 100, 200 and 400 mg/kg (Table 7).

Effect of *Bombax buonopozense* extract on Forced swim test

The extract of *Bombax buonopozense* significantly ($p<0.05$) decreased the duration of immobility in forced swim model when compared with distilled water treated group across the doses of 100, 200 and 400 mg/kg (Table 8).

Table 1: Phytochemical Constituents of *Bombax buonopozense* Extract

Phytochemical	Inference
Flavonoids	+
Alkaliods	+
Phenols	+
Saponins	+
Tannins	+
Anthraquinones	+
Cardiac glycosides	-
Steroids	+

Keys: + = Present, - = absent

Table 2: Mineral elements of *Bombax buonopozense*

Elements	Symbols	% Composition
Zinc	Zn	0.41
Aluminium	Al	0.78
Chlorine	Cl	2.03
Phosphorous	P	0.92
Sulphur	S	0.17
Silicone	Si	2.23
Potassium	K	5.30
Calcium	Ca	24.10
Manganese	Mn	0.32
Iron	Fe	2.32
Magnesium	Mg	0.41
Rhadmium	Rb	0.17

Table 3: Effect of *Bombax buonopozense* ethanol stem-bark extract on MK 801-Induced Hyperactivity in open field test

Treatments (mg/kg)	Number of central square cross	Number of peripheral square cross
Distilled water 10ml/kg	8.81 ± 0.91	14.81 ± 0.74
BBE 100	7.30 ± 0.45	12.30 ± 1.10
BBE 200	6.10 ± 1.07	6.13 ± 1.20*
BBE 400	3.12 ± 0.63*	4.12 ± 1.60*
Risperidone 1	1.62 ± 0.21*	0.73 ± 0.15*
Normal control	6.30 ± 0.60	8.14 ± 1.02

Values were presented as mean ± standard error of mean, analyzed using one way ANOVA followed by Bonferroni's post hoc test
*= $p< 0.05$ as compared to distilled water treated group, BBE = *Bobax buonopozense* extract,

Table 4: Effect of *Bombax buonopozense* extract on MK 801-Induced cognitive impairment in Novel Object Recognition Test

Treatments (mg/kg)	TENO (s)	TEFO (s)	R.I (%)
Distilled water 10ml/kg	58.04 ± 11.60	84.81 ± 3.10	43.23 ± 2.03
BBE 100	26.30 ± 2.07	27.21 ± 1.86	50.10 ± 1.05
BBE 200	22.10 ± 1.21	20.11 ± 1.03	53.51 ± 1.20
BBE 400	29.31 ± 2.54	21.34 ± 1.2	58.16 ± 1.16*
Risperidone 1	15.03 ± 1.21	12.11 ± 1.13	58.13 ± 2.10*
Normal control	133.0 ± 12.1	98.40 ± 3.20	59.12 ± 4.40#

Values were presented as mean ± S.E.M, analysed using on- way ANOVA followed by Bonferroni's post hoc test *= p< 0.05 as compared to distilled water treated group, # = significance at p< 0.05 as compared to distilled water group –, BBE= Bombax buonopozense Extract, TENO = Time exploring novel object, TEFO = Time exploring familiar object, R.I = Recognition index

Table 5: Effect of *Bombax buonopozense* extract on MK 801-Induced Spatial Memory Impairment in Y- maze Test

Treatments (mg/kg)	Number of Actual alternations	Number of Visible alternations	Spontaneous Alternation (%)
Distilled water 10ml/kg	3.21 ± 0.31	11.32 ± 1.42	33.5 ± 2.6
BBE 100	4.00 ± 0.25	9.18 ± 0.73	49.1 ± 3.2
BBE 200	6.20 ± 0.31	12.21 ± 0.31	61.0 ± 4.2*
BBE 400	8.25 ± 0.83	11.03 ± 0.72	91.2 ±2.1*
Risperidone 1	7.41 ± 0.52	10.21 ± 0.45	89.25 ± 3.6*
Normal control	8.03 ± 0.46	10.52 ± 0.68	93.22 ± 3.0

Values were presented as mean ± S.E.M, analysed using one way ANOVA followed by Bonferroni's post hoc test *= p< 0.05 as compared to distilled water treated group, BBE = *Bombax buonopozense* Extract

Table 6: Effect of *Bombax buonopozense* extract on Psilocybin induced hyperactivity in rats

Treatments (mg/kg)	Number of central square crossing	Number of Climbing
Distilled water 10ml/kg	5.24 ± 0.80	13.20 ± 1.12
BBE 100	7.03 ± 0.82	11.21 ± 0.42
BBE 200	9.51 ± 0.82	14.51 ± 0.46
BBE 400	11.33 ± 0.65	13.06 ± 0.95
Risperidone 1	10.57 ± 0.63	12.41 ± 0.61
Normal control	11.05 ± 0.88	12.51 ± 0.72

Values were presented as mean ± S.E.M, analyzed using one way ANOVA followed by Bonferroni's post hoc test *= p< 0.05 as compared to distilled water treated group, BBE = *Bombax buonopozense* Extract, DW = distilled water

Table 7: Effect of *Bombax buonopozense* extract on Catalepsy Duration

Treatments (mg/kg)	Catalepsy (sec)
DW 10 ml/kg	28.0 ± 4.32
BBE 100	24.01 ± 4.12
BBE 200	15.23 ± 1.4
BBE 400	16.20 ± 2.40
Risperidone 1	16.73 ± 1.15

Values were presented as mean ± S.E.M, analyzed using one way ANOVA followed by Bonferroni's post hoc test *= p< 0.05 as compared to distilled water treated group, BBE = *Bombax buonopozense* extract. DW = distilled water

Table 8: Effect of *Bombax buonopozense* extract on Duration of Immobility in Forced Swim Test.

Treatments/ dose (mg/kg)	Duration of Immobility (minutes)
Distilled water 1ml/kg	2.78 ± 0.21
BBE 100	2.51 ± 0.22
BBE 200	1.66 ±0.11*
BBE 400	1.22 ± 0.22*
Risperidone 1	0.94 ± 0.34*

Values were presented as mean ± S.E.M, analysed using one-way ANOVA followed by Bonferroni's post hoc test *= p< 0.05 as compared to Distilled water treated group, # = significance at p< 0.05 as compared to distilled water treated group, BBE = *Bombax buonopozense* extract.

DISCUSSION

The preliminary phytochemical screening of the *Bombax buonopozense* extract showed the presence of tannins, saponins, flavonoids, steroids, alkaloids and no cardiac glycoside was detected. Large varieties of plants containing a wide variety of phytochemicals as their bioactive principles have been reported to

alter central nervous system activities (Danjuma *et al.,* 2010).

The extract of *Bombax buonopozense* also significantly increased the percentage spontaneous alternation in Y- maze; inferring positive neurocognitive effect, the extract enhanced short term spatial memory and attenuate the anterograde amnesia induced by MK 801 administration (Minae *et al.,* 2011). While spatial learning and acquisition are highly dependent on hippocampal–neocortical pathways, performing an attentional shift to learn a new rule depends primarily on PFc–striatal pathways, which would appear to be preferentially affected by social isolation from weaning (Quan *et al*., 2010), the phytochemicals of this extract may likely interact with the receptors in these brain regions and reverse the cognitive deficit induced by MK 801.

Humans and rodents alike have an innate curiosity to preferentially explore novel over familiar objects. Assessment of this differential exploration forms the basis of the novel object recognition task, which is thought to assess visual episodic memory (Dere *et al*., 2007) and to map in a translational manner to the visual learning and memory domain affected in schizophrenia (Young *et al*., 2009).

In this study, *Bombax buonopozense* extract significantly reversed the MK 801 induced hyperactivity at doses 200 and 400 mg/kg. The stimulation of locomotor activity has been mainly attributed to the dopaminergic hyperactivation in the striatal areas of mice brain (Irifune *et al.,* 1991). It has been also reported that dopamine neurotransmission is involved in the motor activating effects of NMDA, since the systemic administration of dopamine antagonists counteracts the motor activation induced by the systemic administration of NMDA (Gimenez-Llort *et al.,* 1997). Moreover, dopamine released in the nigrostriatal neurons remains in direct presynaptic control of glutamate via both alpha amino-3-hyroxy-5-methyl-propanoic acid (AMPA) and N-methyl-D-aspartate (NMDA) receptors located in nerve terminals of dopaminergic neurons (Cheramy *et al.,* 1998). An indirect inhibitory regulation of dopamine release was also demonstrated due to the combined stimulatory effect of N-methyl-D-aspartate on the medium sized GABAergic efferent neurons. Also, a possible mechanism by which ketamine might produce this adverse behavioural effects have been related to the blockade of NMDA receptors located on inhibitory GABAergic neurons in the limbic and subcortical brain regions (Nakao *et al.,* 2003). The findings in this study indicate the likelihood that *Bombax buonopozense* phytochemical(s) elicits its activity via antagonism of dopamine receptors and modulation of NMDA receptor.

The prolonged duration of immobility after subchronic administration of MK 801 has been used previously to mimic the negative symptoms of schizophrenia, such as flattening of affect and avolition. Subchronic administration of *Bombax buonopozense* extract reduced the duration of immobility in the forced swim test, similar to risperidone. The efficacy of atypical antipsychotic agents is believed to be through their $5HT_{2a}$ receptor antagonism (Kawaura *et al*., 2015). Thus, the methanol leaf extract of *Bombax buonopozense* likely interacts negatively with this serotonin receptor. A similar finding as reported by Minea *et al.* (2011) in animal studies.

Catalepsy test in rodents is a predictive tool for detecting the extrapyramidal side effects (EPS) that is known to account for the discontinuation of antipsychotic drug use in patients. Consequently, current research for new antipsychotic drug discovery is focused on agents with minimal or no EPS in addition to clinical efficacy (Bricker *et al.,* 2014).

Psilocybin is a natural indoleamine hallucinogen that produces schizophrenia-like symptoms primarily through $5\text{-}HT_{2a}$ receptor stimulation. It was reported to produce a clinical syndrome that resembles the first episode of schizophrenia (Gouzoulis *et al.,* 1998). Similar findings have also been reported for the structurally related indoleamine hallucinogen lysergic acid diethylamide (LSD). Psilocybin in normal subjects produced a marked prefrontal cortex activation manifested as euphoria and thought disorder (Warburton, 2018). Extract of *Bombax buonopozense* was able to reduces the hyperactivity induced by psilocybin in mice; an effect likely elicited through antagonism of $5HT_{2a}$ receptors.

CONCLUSION

It can be concluded that *Bombax buonopozense* possess neuropharmacological effects with therapeutic potential in ameliorating psychotics symptoms induced by neuro-stimulants.

ETHICAL CONSIDERATIONS

Compliance with ethical guidelines

This study was approved by the Ethical committee on experimental animals use of the Usmanu Danfodiyo University Sokoto.

Ethics Committee of Guilan University of Medical Sciences

(Approval Number: AREC.FPS.UDUS.0017).

FUNDING
Funding for this study was provided by the Institutional Based Research Grant, IBR Batch 10 Usmanu Danfodiyo University, Sokoto

Authors' contributions
All authors equally contributed to preparing this article.

Conflict of interest
The authors declared no conflict of interest.

REFERENCES

Akanmu M.A., Adeosun S.O., & Ilesanmi O.R. (2007). Neuropharmacological effect of oleamide in male and female mice, *Behavioral brain research*, 182(1):88-94.

Amann LC, Gandal MJ, Halene TB, Ehrlichman RS, White SL, McCarren HS et al (2010). Mouse behavioral endophenotypes for schizophrenia. *Brain Research Bulleting,* 2010; 83: 147–16.

Bricker B., D. Sampson, & S. Y. Ablordeppey (2014), Evaluation of the potential of antipsychotic agents to induce catalepsy in rats: assessment of a new, commercially available, semi-automated instrument, *Pharmacology Biochemistry and Behavior*, vol. 120, pp. 109–116,

Cheramy, A., L'Hirondel, M., Godeheu, G., Artaud, F., & Glowinski, J. (1998) Direct and indirect presynaptic control of dopamine release by excitatory amino acids, *Amino Acids and proteins,* 14:63–68

Danjuma, N.M., Saulawa, H.T., Zezi, A.U., Yaro, A.H., Giwa A. & Magaji, M.G. (2011). Anticonvulsant properties of methanol stem bark extract of Acacia albida Del, *Journal of pharmacology and tropical therapeutics*, 1(1):40-46.

Dere E, Huston JP, & De Souza Silva MA (2007). The pharmacology, neuroanatomy and neurogenetics of one-trial object recognition in rodents, *Neuroscience Biobehaviour Review,* 31: 673–704.

Gimenez-Llort L, Martinez E, Ferre S (1997) Different effects of dopamine antagonists on spontaneous and NMDA-induced motor activity in mice, *Pharmacology Biochemical and Behavioral science,* 56:549–553

Gouzoulis-Mayfrank E, Hermle L, Thelen B et al (1998), *Pharmacopsychiatry,* 31 (Supp), 63–68.

Irifune M, Shimizu T, Nomoto M (1991) Ketamine-induced hyperlocomotion associated with alteration of presynaptic components of dopamine neurons in the nucleus accumbens of mice, *Pharmacological Biochemical Behavior,* 40:399–407

Kawaura K, koikeh H, Kinoshita K, Kambe D, Kaku A, Karasawa J, Chaki S AND Hikichi H. (2015). Effects of a glycine transporter-1 inhibitor and D-serine on MK-801-induced immobility in the forced swimming test in rats, *Behavioral Brain Research*, 278: 186-192.

Lieberman JA, Tollefson GD, Charles C, Zipursky R, Sharma T, Kahn RS: (2005). Antipsychotic drug effects on brain morphology in first-episode psychosis, *Archieved of General Psychiatry,* 62: 361–370.

Meltzer, H (2010) Antipsychotic agents and lithium. In: Katzung BG, Masters SB, Trevor AJ (eds), *Basic and clinical pharmacology*, McGraw-Hill Companies, New York

Meyer, J.M. (2011) Pharmacotherapy of psychosis and mania. In: Brunton L, Chabner B, Knollman B (eds) Goodman and Gilman's The pharmacological basis of therapeutics. McGraw-Hill, New York.

Minae Niwa, Yurie Matsumoto, Akihiro Mouri , Norio Ozaki and Toshitaka Nabeshima (2011). Vulnerability in early life to changes in the rearing environment plays a crucial role in the aetiopathology of psychiatric disorders, *International Journal of Neuropsychopharmacology*, 14, 459–477. doi:10.1017/S1461145710001239.

Molina, D. Kimberley; DiMaio, Vincent J. M. (2015). Normal Organ Weights in Women. The *American Journal of Forensic Medicine and Pathology*, 36 (3): 182–187. doi:10.1097/PAF.0000000000000175.

Nakao S, Nagata A, Miyamoto E, Masuzawa M, Murayama, T., & Shingu, K. (2003) Inhibitory effect of propofol on ketamine-induced c-Fos expression in the rat posterior cingulate and retrosplenial cortices is mediated by GABAA receptor activation, *Acta Anaesthesiology Scand,* 47:284–290.

Porsolt, R.D., Bertin< A., & Jalfre, M. (1977) Behavioral despair in mice: a primary screening test for antidepressants, *Archieve International Pharmacodynamics and Therapeutic,* 229:327–336.

Quan M.N., Tian, Y.T., Xu, K.H., Zhang, T., & Yang, Z. (2010). Post weaning social isolation influences spatial cognition, prefrontal cortical synaptic plasticity and hippocampal potassium ion channels in Wistar rats, *Journal of Neuroscience,* 169: 214–222.

Rang, H.P., Ritter, J.M., Flower, R.J. and Henderson, G. (2016). *Rang and DalesPharmacology*, 8th edition. Churchill Livingstone, Elsevier science limited, pp. 449.

Selemen, L.D., & Zecevic, N. (2015). Schizophrenia: a tale of two critical periods for prefrontal cortical development, *Journal of Translasional Psychiatry* (2015) 5, e623; doi:10.1038/tp.2015.115.

Van, O.S.J, Kenis, G., & Rutten, B.P.F. (2010). The environment and schizophrenia. *Nature* 468: 203–212.

Warburton, E.C. (2018). Using the spontaneous object recognition memory tasks to uncover the neural

circuitry of recognition memory: The importance of thalamic nuclei. In: Ennaceur, A. and De Souza Silva, M.A. (Eds), *Handbook of object novelty recognition*, Academic press, UK, pp. 197-203.

World Health Organization. (2022). WHO global report on traditional and complementary medicine (2022). World Health Organization. https://iris.who.int/handle/10665/31234254.

Young, J.W., Powell, S.B., Risbrough, V., Marston, H.M., & Geyer, M.A. (2009). Using the MATRICS to guide development of a preclinical cognitive test battery for research in schizophrenia, *Pharmacology and Therapeutic,* 122: 150–202.