Original Article

Comparative Study of Central Nervous System Effect of *Santalum album* Linn. Paste Fragrance v/s Aqueous Extract in Wistar Albino Rats

Madhusudan P Joshi, Sneha R Satarkar*, Vedita Hegde Desai

Department of Pharmacology, Goa College of Pharmacy, Panaji, Goa 403001, India.

Address for Correspondence

Goa College of Pharmacy, 18th June Road, Panaji, Goa Pincode: 403001 Tel:+91-8806617006.
E-mail: snehasatarkar@gmail.com

ABSTRACT

This study was designed to investigate the difference in CNS effects of *Santalum album* L. administered via oral route and inhalational route. The aqueous extract (4 ml) and fragrance of paste was administered to rats for continuous period of 7 days. The pharmacological activities assessed were spontaneous behaviour using autotrack instrument and analgesic activity using hot plate analgesia meter. Diazepam (4mg/kg) and Pentazocine (5 mg/kg) served as standard drugs. Statistical analysis of the obtained results was carried using one way ANOVA followed by Dunnett's test. Both the extracts expressed significant sedative action as indicated by reduction in mobility of rats as compared to control groups. The aqueous extract produced better sedation and the effect was seen to be cumulative. Analgesic effect was not clear from the obtained results.
It can be concluded from the study that *Santalum album* Linn. administered by oral route had more prominent central nervous system effect.

Keywords: *Santalum album* Linn, autotrack, analgesia meter, sedation.

INTRODUCTION

Drugs can be administered by various routes. Route of administration plays a critical role in the bioavailability of the drug in the body. Oral route is the most commonly prescribed route as it is most convenient, pain free and cheap. Absorption of drug takes place along the whole length of GI tract[1]. Inhalational route is another route of drug administration which is used for the administration of volatile components like aromas of essential oils. Therapeutic uses of fragrance or at least mere volatiles to cure and to mitigate or to prevent diseases, infection and indisposition only by means of inhalation is termed as "aromatherapy", this definition has been proposed by G. Buchbauer[2]. Previous studies carried out have shown that some

odorants exert stimulant or inhibitory effects on the brain function.Smells are thought to stimulate the olfactory system and produce signals that project to the olfactory bulb, where smell images are produced, analyzed and recognized by the brain. The olfactory bulb is part of the limbic system, along with the hippocampus, amygdala and hypothalamus. Olfactory stimulation is likely to have some effect on these organs. The hippocampus is important for memory establishment and recollection, while the amygdala is related to fear and stress responses. The hypothalamus controls the autonomic nervous, endocrine and immune system. Thus, fragrances have some effect on our mental state, mood or consciousness, through stimulation of the olfactory system[3].

The aim of this study was to investigate difference in central nervous system effect of *Santalum album* Linn. paste fragrance and aqueous extract.*Santalum album* L. (Santalaceae) is a small evergreen tree commonly known as sandalwood, sandal tree. The sapwood is white and odourless, the heartwood is yellowish brown and strongly scented[4].Over 90 per cent of sandalwood is distributed in Karnataka and Tamil Nadu and rest in Andhra Pradesh, Orissa, Madhya Pradesh and Maharashtra[5].

Medicinally sandalwood is useful in biliousness, fever and thirst. It is applied externally in the form of paste with water or rose water to skin eruptions, to the temples in headaches, fevers, to skin diseases to allay itching, inflammation, heat and pruritus[6].The aromatic nature of sandalwood is calming to an aggravated nervous system; it balances vyanavayu and cools sadhaka pitta, making it useful for treating depression and mental disturbance[7]. *Santalum album* L. is found to possess memory enhancement potential[8-9]. Sedative effect of *Santalum album* L. was discovered by Buchbauer's team. They found that inhalation of East Indian sandalwood oil decreased the motility of mice to an extent of 40-78% compared with 0% control[2].

Sedative effect of sandalwood oil and aqueous extract has already been proved[2,10]. However literature survey revealed that so far no study has been carried out with sandalwood paste. Also, so far no research work has been done comparing the CNS effect of *Santalum album* L. administered by oral route and inhalational route. Therefore the present study was undertaken.

MATERIALS AND METHODS

Plant Material

Wood of *Santalum album* L. was obtained from the pharmacy of Gomantak Ayurveda Mahavidyalaya and Research Centre, Shiroda-Goa and was identified and authenticated by Dr. S.K. Das, H.O.D. Department of Dravyaguna, Gomantak Ayurveda Mahavidyalaya and Research Centre, Shiroda-Goa.

Preparation of paste

Santalum album L. was ground to fine paste using water on sandalwood grinding stone. (Fig. 1)

Preparation of aqueous extract

The wood of *Santalum album* L. was ground to thick paste using little quantity of water. 10 gm of paste was taken in 30ml of water. It was kept overnight, and filtered next day using muslin cloth.For animal studies extract was freshly prepared everyday.

Phytochemical screening

Phytochemical screening of the aqueous extract was carried out for the presence of various phytoconstituents qualitatively[11].

Chemicals

Diazepam and pentazocine were used as standard drugs.

Instruments

Opto-Varimex (Columbus instrument), Hot Plate Analgesia Meter (Columbus instrument).

Experimental Animals

Female wistar albino rats weighing about 150-200g were purchased from National Institute of Biosciences, Pune, Maharashtra, India.The animals were housed in polypropylene cages maintained under standard condition (temperature 25 ± 2°C, relative humidity 55 ± 10 % and 12 h. light : 12 h. dark cycle) and had free access to standard pelleted rat feed and water ad libitum. All the animals were acclimatized to laboratory condition for a week before commencement of experiment (CPCSEA guidelines). All experimental protocols were reviewed and accepted by the Institutional Animal Ethical Committee (IAEC) prior to the commencement of the experiment. (Ref: GCP/IAEC/13/05)

The animals were randomly allocated to 6 groups of 6 animals each: -Group I - water, served as control for group which received aqueous extract and standard drugs. (p.o.), Group II- simulated, served as control for the group which received fragrance of *Santalum album* L.paste, Group III - received diazepam (4 mg/kg) which served as standard for locomotor activity. (i.p.), Group IV - received pentazocine (5 mg/kg), which served as standard for analgesic activity. (i.p.), Group V- received 4 ml of aqueous extract of *Santalum album* Linn. (p.o.), Group VI- received fragrance of *Santalum album* Linn. paste (inhalation).

Experimental Protocol

Dose administration

The test solution was administered to the rats by oral route using oral feeding needle.And the positive (diazepam 4mg/kg and pentazocine 5mg/kg) were administered to the rats by intraperitoneal injection.

Administration of fragrance to rats

Fragrance was administered to rats using "*inhalation apparatus*".

Set up for "inhalation apparatus"

Inhalation apparatus consisted of polypropylene cage having dimension 24×17×15 cms, covered with metal lid. Husk was used as bedding material. Muslin cloth was cut into rectangular shape (3×4 cm). This rectangular cloth piece was tied to a string and then tied to the lid of rat cage at the height of 9 cm from the bottom of the cage, as shown in Fig.3. Four pieces of muslin cloth were tied at the four corners of the cage to form the "*inhalation assembly*".

4-5 layers of *Santalum album* L. paste were applied to the cloth incase of test group. For simulated group cloth pieces were simply tied without paste application.

Screening Methods

1. Screening method for spontaneous behaviour of rats

Spontaneous behaviour was recorded individually for each animal in Opto-Varimex instrument (Columbus) with Auto-track software[12]. The rats were individually weighed and numbered. After 30 mins of administration of positive control (Diazepam p.o.), aqueous extract (p.o.), paste (inhalationally), distilled water (control group) and the placebo (simulated group) the rats were tested for locomotor activity. The instrument was operated using the SOP (Standard Operating Procedure). The treated and the control group of rats were placed

individually in the activity cage for 1 minute and basal activity score for 30 min, 1 hour, 4 hours and 8 hours was noted. The difference in locomotor activity between the groups was evaluated by analyzing the difference in the various parameters monitored in the test. These included Distance travelled (DT) in cm, Resting time (RT) in sec, Stereotypic time (ST) in sec, Ambulatory time (AT) in sec. The procedure was repeated on the fourth and seventh day, so as to obtain the readings for the same.

2. Screening method for analgesic activity

The analgesic activity of the extracts was measured using Hot plate method[12]. The instrument was operated using the Standard procedure (SOP).The rats were individually weighed and numbered.The temperature of the electrically heated surface of the Hot Plate Analgesia Meter was maintained at 55°C. After 1 hour of administration of the positive control (pentazocine, i.p.), aqueous extract (p.o.), paste (inhalationally), distilled water (control group) and placebo (simulated group) the rats were individually placed on the hot plate. The time until the paw licking or jumping response occurred was recorded. This was noted as the reaction time. The cut off time of 15 sec was maintained in order to avoid any damage to the paws of the rats.The readings were recorded after 1 hour, 4 hours and 8 hours following administration of test and control.The experiment was repeated and readings were noted again on the fourth and seventh day. The readings obtained for the control and test groups were compared in order to evaluate the effect of the test extract for analgesic activity.

Statistical Analysis

The results obtained were expressed as mean ± SEM. Statistical analysis of the results was carried using one way ANOVA followed by Dunnet's test using GraphPadInStat 3.0 software.

RESULTS

Phytochemical screening

Preliminary phytochemical screening of the aqueous extract of *Santalum album* Linn. Revealed the presence of carbohydrates, flavonoids, alkaloids and tannins. The results of phytochemical analysis are tabulated in Table No. 1.

Opto-varimex instrument

On continous administration of *Santalum album* L. aqueous extract for a period of 7 days, it was seen that Group V showed more prominent decrease in spontaneous activity of the rats on 7th day compared to 4th day. On day 1 no significant decrease in spontaneous activity was observed for both Group V and VI. RT of Group V increased from day 1 to day 7 as compared to control. AT of Group V reduced from day 4 to day 7. The results obtained for ST were found to be inconsistent for both the test groups. The DT of Group VI reduced from day 4 to day 7 as compared to control but significant results were obtained at 4 hour of day 4, 4 hour and 8 hour of day 7.The results of day 1-7 are as indicated in Table No. 3 and 4.

Hot plate Analgesia Meter

Aqueous extract showed significant increase in reaction time of rats on day 1 at 1 hour and on day 4 at 1 hour and 8 hours. On day 7 though there was increase in reaction time for Group V, the increase was not significant when statistically compared to control, therefore it is not clear from the obtained results if AESA (aqueous extract of *Santalum album*) has analgesic activity.Paste fragrance inhalation did not alter the reaction time of rats when compared to simulated group.The results of the experiment are tabulated in Table No.2.

DISCUSSION

It is long known that inhalation of aromas causes physiological and psychological changes in humans and it is assumed that the effects of aromas are evoked by both pharmacological and psychological mechanisms[13].The volatile compound inhaled with the air can enter the blood stream by way of the nasal or lung mucosa-or perhaps through diffusion into nervous tissue[14]. Smell is usually perceived together with visual, auditory or tactile stimulation. These sensory systems work synergistically to affect the mental and physical state of humans[3].

This study evaluated difference in CNS effects of *Santalum album* L. paste fragrance and aqueous extract administered orally using Opto-varimex instrument and Hot plate Analgesia Meter.

Phytochemical screening of the aqueous extract was carried out. It revealed the presence of carbohydrates, alkaloids, flavonoids and tannins. There was absence of proteins, amino acids, steroids, triterpenoids, cardiac glycosides, anthraquinone glycosides and saponin glycosides. Hence through phytochemical screening various classes of chemical compounds present in aqueous extract of *Santalum album*L. were confirmed.Flavonoids are known to have effect on CNS.They may interact with the $GABA_A$-receptor, producing sedation, anxiolytic or anticonvulsive effects[15]. Aqueous extract showed the presence of flavonoids so these could be responsible for sedative activity shown by the aqueous extract.

Motor activity is a good index for studying the effects of pharmacological agents. Spontaneous motor activity depends on various factors, such as the social situation (one or more animals), familiarity with the test environment, light and temperature. The term spontaneous motor activity includes different types of movements, such as locomotion, rearing, sniffing, grooming, eating and drinking[12].

Locomotor activity is considered as an index of alertness and a decrease leads to sedation as a result of reduced excitability of central nervous system.

In the present study locomotor activity was studied using Opto-varimex instrument. Our findings suggest that the aqueous extract and the fragrance of *Santalum album* Linn. have sedative effect on CNS of rats.It was observed that on continous administration of aqueous extract, there was reduction in spontaneous behaviour of rats. The reduction in distance travelled and increase in resting time is the effect often shown by many sedative drugs. Sedative effect was found to be cumulative.The decrease in spontaneous behaviour shown by aqueous extract was found to be more on 7^{th} day indicating that aqueous extract of *Santalum album* L. produces better effect on chronic administration.

Inhalation of fragrance of *Santalum album* L. paste also produced decrease in locomotor activity of rats. But the sedative effect was not found to be cumulative. Aqueous extract administered orally produced better sedation than the paste fragrance inhalation.

Okugawa et al., has concluded in his study that α- and β-santalols contribute to the sedative effect of sandalwood[10]. Through literature review it was found that santalol, the principal constituent of *Santalum album* L. is practically insoluble in water. In our study the aqueous extract has shown prominent sedative activity in rats. So, this suggests that in addition to santalol, there could be other compounds responsible for the sedative effect of *Santalum album* L.

Pain is a protective mechanism. Pain occurs whenever any tissues are being damaged, and it causes the individual to react to remove the pain stimulus. Some of the chemicals that excite pain are bradykinin,

serotonin, histamine, potassium ions, acids, acetylcholine, and proteolytic enzymes. In addition, prostaglandins and substance P enhance the sensitivity of pain endings but do not directly excite those[16].

The analgesic activity was assessed using Hot plate method. The paws of mice and rats are very sensitive to heat at temperatures which are not damaging the skin. The responses that are observed are jumping, withdrawal of the paws and licking of the paws. The time until these responses occur is prolonged after administration of centrally acting analgesics, whereas peripheral analgesics of the acetylsalicylic acid or phenyl-acetic acid type do not generally affect these responses. The hot plate consists of an electrically heated surface. The temperature is controlled for 55° to 56 °C. This can be a copper plate or a heated glass surface. The animals are placed on the hot plate and the time until either licking or jumping occurs is recorded by the software[12].

It is not clear if the AESA has analgesic activity as significant results were obtained only on day 1 and day 4. On day 7 there was increase in reaction time as compared to control but the increase was found to be insignificant on statistical analysis.

CONCLUSION

The present study suggests that *Santalum album* Linn. administered by oral route exhibits more prominent CNS effects than by inhalational route. The aqueous extract administered by oral route produced better sedation than the fragrance given inhalationally. Analgesic activity is not clear from the obtained results.

ACKNOWLEDGEMENT

The authors are thankful to Goa College of Pharmacy, Panaji, Goa and Goa University- Taleigao Plateau, Goa, for providing all the necessary amenities to carry out the research work effectively.

REFERENCES

1. Verma P , Thakur AS, Deshmukh K, Jha AK, Verma S. Routes of drug administration. *IJPSR*. 2010; 1: 54.
2. Khanna A, Singh VK,Govil JN. Aromatherapy. In,Recent progress in medicinal plants: Aesthetics. USA: Stadium Press; 2004: 125.
3. Aoshima H.Beneficial Effects of Fragrances in Beverages on Human Health. In,Bouayed J (ed). Nutrition, Well-Being and Health. Croatia, Europe: In Tech;2012:120.
4. Kirtikar KR,Basu BD.Indian medicinal plants. Vol5.,Uttaranchal: International book distributorsDehradun; 2005: 2186.
5. Ramya R. Physiological and genetic diversity studies on regeneration of *Santalum album* L. Ph.D. thesis, Cochin University of Science And Technology, Thrissur, Kerala, 2010.
6. Nadkarni KM. Indian materiamedica. Mumbai: Mumbai popular Prakashan; 2009: 1099.
7. Pole S.Plant profiles. In,Ayurvedic medicine: The principles of Traditional practice. USA:Churchill Livingstone; 2006: 262.
8. Jackson DD, Shiju L, Jebasingh D,Huxley VAJ. Memory enhancement potential of *Santalum album* extracts on albino mice. *Journal of Theoretical and Experimental Biology*.2009; 5: 3.
9. Biradar SS, Rasal VP, Ashok P. Sandalwood Oil treatment during growth spurt period improves learning and enhances memory.*Pharmacologyonline*. 2009; 3: 142.
10. Okugawa H, Ueda R, Matsumoto K, KawanishiK,Kato A. Effect of α-santalol and β-santalol from sandalwood on the central nervous system in mice. *Phytomedicine*.1995; 2: 119.
11. Kokate CK, Purohit AP,Gokhale AP.Pharmacognosy.44th ed., Pune: NiraliPrakashan; 2009: A.2.
12. Vogel GH (editor).Drug discovery and Evaluation: Pharmacological Assays. 2nd

ed.,New York: Springer- Verlag Berlin Heidelberg; 2002: 696.
13. Hongratanaworakit T. Physiological effects in aromatherapy. *Songklanakarin J. Sci. Technol*. 2004; 26: 118.
14. Jellinek S. Psychodynamic Odor Effects and Their Mechanisms. *Perfumer and Flavorist*.1997; 22: 29.
15. Jager KA, Saaby L. Flavonoids and the CNS. *Molecules*.2011; 16: 1472.
16. Guyton AG, Hall HE.Somatic Sensations: II. Pain, Headache and Thermal sensations. In,Textbook of medical physiology. 11th ed., USA: Churchill Livingstone; 2006: 598.

Table 1. Preliminary phytochemical screening of the aqueous extract of *Santalum album* Linn

Sr. No.	Phytoconstituents	AESA
1.	Carbohydrates	+
2.	Proteins	_
3.	Steroids and Triterpenoids	_
4.	Glycosides	_
5.	Flavonoids	+
6.	Alkaloids	+
7.	Tannins	+

Table 2. Effect of aqueous extract and paste fragrance of *Santalum album* Linn.on analgesic activity using Hot Plate Analgesia Meter

Treatment	Time in hours	Reaction Time (sec)		
		Day 1	Day 4	Day 7
Control (Group I)	1	1.033 ± 0.292	1.017 ± 0.315	1.433 ± 0.462
	4	1 ± 0.202	1.45 ± 0.254	1.217 ± 0.209
	8	1.65 ± 0.281	1.317 ± 0.264	1.583 ± 0.196
Simulated Group (Group II)	1	1.733 ± 0.175	1.567 ± 0.159	1.083 ± 0.142
	4	1.767 ± 0.171	1.5 ± 0.121	1.2 ± 0.118
	8	1.45 ±0.186	1.567 ±0.148	1.25 ± 0.103
Standard (Group IV)	1	4.683 ± 0.486**	4.683 ± 0.459**	5.117 ± 0.474 **
	4	3.083 ± 0.708*	4.017 ± 0.648 **	4.767 ± 0.504 **
	8	2.35 ± 0.845	1.867 ± 0.532	2.85 ± 0.279
AESA (Group V)	1	2.417 ± 0.306*	2.967 ± 0.367*	1.967 ± 0.209
	4	1.933 ± 0.102	2.033 ± 0.343	2.217 ± 0.396
	8	2.15 ± 0.120	2.817 ± 0.346*	1.85 ± 0.286
Paste Fragrance Inhalation (Group VI)	1	2.183 ± 0.578	2.117 ± 0.164	2.15 ± 0.057
	4	1.983 ± 0.098	2.317 ± 0.204	2.133 ± 0.474
	8	1.983 ± 0.098	2.483 ± 0.215	1.867 ± 0.148

Values are expressed as mean ± SEM (n= 6) *P<0.05, **P<0.01, ***P<0.001 vs. Control

Paste fragrance inhalation group vs. simulated group.

Table 3. Effect of aqueous extract and paste fragrance of *Santalum album* Linn.on spontaneous behaviour of rats using Opto-Varimex instrument

Treatment	Time in hours	Day 1		Day 4		Day 7	
		DT (cm)	RT (sec)	DT (cm)	RT (sec)	DT (cm)	RT (sec)
Control (Group I)	0.5	341.5±43.284	7.833±1.493	347.667±26.266	9.833±2.915	323.33±72.593	11.166±2.713
	1	351.833±25.424	13.5±3.766	386.333±15.134	5.833±1.447	325.833±18.613	8.666±2.028
	4	362 ± 11.986	15.666±2.629	374.167±29.225	11.833±0.601	298.33±27.365	9.833±1.195
	8	315.167±17.459	14.167±4.534	354.5±23.796	10±1.390	312.333±15.870	12.666±2.418
Simulated group (Group II)	0.5	474.667±29.051	4.833±2.040	371.333±30.025	9.833±1.138	443.333±63.059	5.5±1.565
	1	402.5±32.530	4.167±1.537	336.167±51.946	7.833±3.280	331.833±29.728	8.333±1.801
	4	329.333±31.198	9.333±2.499	350.167±20.236	4.833±1.229	391.5±16.721	4.833±0.477
	8	343.333±25.318	11±1.633	357.667±10.304	8.667±1.282	349.333±12.829	6.167±0.477
Standard (Group III)	0.5	165.167±48.70*	26.5±6.727*	109±38.802**	30.333±7.379*	71.666±38.296*	43.833±7.162**
	1	147±33.253**	30.167±5.913*	84.66±40.835**	40.333±8.114**	31.666±19.867**	47.833±7.045**
	4	186.667±51.307*	20.833±4.963	122.33±38.437**	27.666±5.414	77.833±30.279**	38±6.476**
	8	113±36.033**	22.833±4.750	180.166±55.332*	21±5.106	108.166±35.791	29.333±4.787**
AESA (Group V)	0.5	365.33±38.419	5±1.549	312.33±42.079	9.333±2.418	142.666±26.018	19.833±3.280
	1	352.16±32.962	7.5±1.147	247.166±31.432*	11±2.098	142.167±36.849**	19.833±4.520
	4	238.667±46.151	14.666±3.676	210.33±33.956**	16.5±2.232	45.117±18.317**	33±5.610*
	8	196.116±45.274	15±4.782	146.33±21.568**	19.167±4.700	85±20.403**	33±4.435*
Paste fragrance inhalation (Group VI)	0.5	343.167±27.093	7±1.549	341.167±34.203	8.333±2.894	351.167±58.431	6.833±1.721
	1	289.833±46.548	9.833±2.227	346.667±60.023	7.667±3.947	295±59.241	9.5±2.377
	4	204.167±45.365	12.5±1.928	134.5±31.533**	22.1±45.365	156.167±38.098**	20.667±6.716
	8	218.667±28.366	21±4.719	239.5±33.024	7±0.730	144.833±38.068**	19.833±2.971*

DT-Distance travelled; RT- Resting Time. Values are expressed as mean ± SEM (n= 6)
*P<0.05, **P<0.01 vs. Control
Paste fragrance inhalation group vs. Simulated group.

Table 4. Effect of aqueous extract andpaste fragrance of *Santalum album* Linn.on spontaneous behaviour of rats using Opto-Varimex instrument

Treatment	Time in hours	Day 1		Day 4		Day 7	
		ST (sec)	AT (sec)	ST (sec)	AT (sec)	ST (sec)	AT (sec)
Control (Group I)	0.5	16 ±2.380	36.167±3.449	19±0.775	31.167±2.750	18.5±2.487	29.833±2.903
	1	19.833±1.815	26.666±4.842	17.667±1.333	36.5±1.945	18.667±1.745	33.5±0.957
	4	20.5±4.752	23.833±3.439	12.167±0.601	35.5±1.727	15.5±1.088	26.5±2.432
	8	17±1.826	28.833±4.854	13.5±1.176	35.833±1.759	16±2.176	31.5±2.172
Simulated group (Group II)	0.5	10.833±1.249	44.333±2.929	15.167±1.014	35.333±2.171	11.333±1.745	43.167±2.949
	1	15±1.238	40.833±2.600	14.167±1.956	38±4.926	14.667±2.348	37±3.864
	4	16.667±1.961	33.167±3.970	15.5±1.478	36±2.671	16.167±0.946	39.667±2.060
	8	14.167±0.792	33.667±1.978	18.167±1.352	34.667±1.726	15.833±1.537	36.167±1.014
Standard (Group III)	0.5	14.333±2.679	19.166±4.847*	15.333±3.127	14.333±4.937*	5.5±2.029**	10.666±5.364*
	1	9.5±1.607**	17.667±3.748	7.833±3.092*	11.833±5.089**	6.5±3.695*	5.667±3.451**
	4	18.167±1.759	21±4.568	19±3.540	13.333±4.394**	13.5±4.023	8.5±3.128*
	8	21±2.733	16.167±4.909	18.5±1.586	20.5±11.701*	16.667±1.874	14±4.789*
AESA (Group V)	0.5	16.667±1.801	38.333±2.275	16.667±1.856	34±3.011	19.5±2.349	20.667±3.211
	1	14±1.528*	38.5±2.045	19±2.113	30±3.416	19.667±1.585	20.5±3.871*
	4	18.667±2.801	26.666±4.169	19.167±1.400	24.333±2.539*	18.833±3.280	8.166±2.762**
	8	20.5±3.704	24.5±5.353	19.5±3.222	21.333±3.593*	14.667±2.044	12.333±2.445**
Paste fragrance inhalation (Group VI)	0.5	14.667±1.498	38.333±1.585	14.5±1.335	37.167±2.358	17±2.066*	36.167±3.572
	1	16.667±2.076	33.5±3.973	17.833±1.641	34.5±3.810	19±2.530	31.5±3.973
	4	21±3.856	26.5±4.877	15.5±2.320	22.333±4.716	16.833±2.386	22.5±4.522*
	8	13.167±0.980	25.333±3.836	24±2.236	29±2.769	21±1.438*	19±3.194*

ST- Stereotypic Time; AT- Ambulatory Time. Values are expressed as mean ± SEM (n= 6)
*P<0.05, **P<0.01 vs. Control
Paste fragrance inhalation group vs. Simulated group.

 ISSN 2321 – 2748

Figure 1. Preparation of paste of *Santalum album* Linn.

Figure 2. *Santalum album* Linn. paste applied to the muslin cloth

 ISSN 2321 – 2748

Figure 3. *Inhalation apparatus*

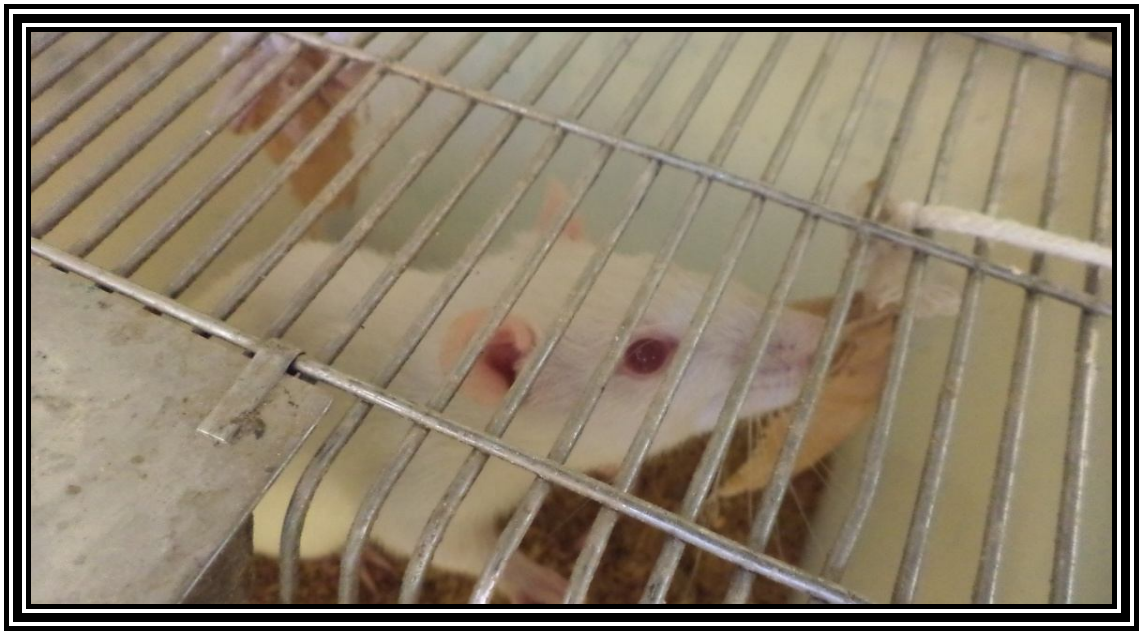

Figure 4. *Rat inhaling the Santalum album Linn. paste fragrance*