DOI: 10.7860/JCDR/2021/47261.14686

Original Article

Anatomy Section

Effect of Inhalation of Pyrethroid Based Mosquito Vaporisers Fumes on the Body Weight of Male Albino Wistar Rats- An Experimental Study

SWATI YADAV[1], RAKESH KUMAR DEWAN[2], ANITA RANI[3], JYOTI CHOPRA[4]

ABSTRACT

Introduction: Pyrethroid based mosquito vaporisers are commonly used as Personal Protective Measure (PPM) to avoid mosquito borne diseases. Effective control of mosquito borne diseases with the use of general public health measures are yet to be achieved in our country, so there is increasing use of PPM like mosquito coils, liquid vaporisers, mats, insecticide treated bed nets in Indian population but data regarding the safety profile of PPM is still scarce.

Aim: To analyse the change in the body weight of male albino wistar rats exposed to pyrethroid based mosquito vaporiser.

Materials and Methods: This was an experimental study on total 12 male albino wistar rats from July 2015 to October 2016. They were randomly divided into group I and II. Each group contained six rats. Group I animals served as control and Group II animals were exposed to mosquito vaporiser, 8 hours/day for six days in a week for 90 days. The data was analysed using Statistical Package for Social Sciences (SPSS) version 21.0. Independent samples t-test was used to compare between group differences. A p-value less than 0.05 were considered to be significant.

Results: Pyrethroid exposure results in reduced weight gain in exposed group rats. The mean difference in body weight between the groups at the end of study was 37.32±24.47 gm (p=0.165). Weight gain in both the group rats was almost similar till 8th postexposure week, after that from 9th week onwards decremental trend in weight was seen in group II.

Conclusion: The assessment suggests that inhalation of pyrethroid based mosquito vaporisers fumes have toxic effects, reflected as reduced weight gain following subchronic exposure.

Keywords: Exposure, Mosquito repellents, Pesticides, Weight loss

INTRODUCTION

A community based cross-sectional study conducted in rural and urban areas, house to house survey, shows that in both rural and urban areas of country, liquid vaporisers are the most preferred method as PPM to overcome mosquito born diseases [1,2]. These vaporisers use mainly type I synthetic pyrethroids as mosquito repellents, which are now most extensively used pesticides worldwide to overcome mosquito borne nuisance and diseases. Its use as PPM in form of mosquito coils, vaporisers and mats is rapidly increasing.

The main active constituents of these Liquid Mosquito Repellent Vaporisers (LMRV) are synthetic pyrethroid which can be allethrin (the first synthetic pyrethroid) or transfluthrin (a form of allethrin). Synthetic pyrethroids are structural derivatives of naturally occurring pyrethrins and have been extensively used in agriculture, horticulture, forestry, home formulations and in public health programs. In commercial formulations, the activity of pyrethroids is usually enhanced by the addition of synergist. Popular brands of LMRV use 0.88% of the chemical, transfluthrin (type I synthetic pyrethroid) as mosquito repellent and kerosene as a solvent [3]. Tranfluthrin is a fast-acting pyrethroid insecticide with low persistency and its molecular formula is C15H12Cll2F4O2. But data about the safety profile of these measures are still scarce [4].

It is claimed that pyrethroids are well-absorbed orally and via inhalation or by skin contact, and pose relatively low risk to mammals due to rapid metabolism by mammalian microsomal enzymes. These type I pyrethroids mainly interact with sodium channels and modify the gating of voltage-sensitive sodium channel on membrane to delay their closure [5]. The pyrethroid group of chemicals are toxic on the enzymatic fraction of the mucosal membrane of the proximal and distal segments of the intestine resulting in reduced intake of food and water by experimental animals [6].

These chemicals have agriculture, domestic and veterinary applications because of their high bio-efficacy, enhanced stability, and comparatively low mammalian toxicity [7]. In tropical countries the use is widespread and the population is exposed during night hours throughout the year including population of all age groups and both sex [8].

Considering these facts, the present study focuses on analysing the effect of subchronic whole body inhalation of pyrethroid containing mosquito vaporiser on body weight of male albino wistar rats.

MATERIALS AND METHODS

The present experimental study was conducted from July 2015 to October 2016 in the Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh. Approval from Institutional Animal Ethical Committee was taken prior to the start of the study (Approval no. 68/IAEC/2015, dated 23/11/15).

Inclusion criteria: Total 12 male albino wistar rats, aged 1-2 months weight 100-150 grams were included in study and randomly divided into two groups.

Exclusion criteria: Female rats were excluded due to cyclic hormonal changes.

After being transferred from their colonies to the Institutional Animal House, rats were kept in a temperature-controlled environment. The baseline weight of each rat was recorded on the day of procurement. Animals were acclimatised for two weeks. Weight of each rat was also recorded during first and second week of acclimatisation. Later the rats were divided into groups and housed in marked polyethylene cages under good hygienic conditions.

Twelve hours light and dark cycle and temperature was maintained. Animals were fed on standard pellet diet (5 gms/rat) and water was given ad libitum according to Committee for the Purpose of Control and Supervision of Experiment on Animals (CPCSEA) guidelines [9]. Daily intake of food and water was recorded.

Group I (Control): Total six rats which were kept without any exposure of fumes, served as control population.

Group II (Experimental): Total six rats, given eight hours daily exposure of LMRV via whole body exposure, for six days in a week for a total of 12 weeks.

In the beginning of 3rd week, rats of group II were exposed to LMRV via whole body inhalation route. For this purpose the exposure groups were kept in a properly ventilated room. After removing the cap of liquid vaporiser bottle (containing Transfluthrin: 0.88% w/w) was inserted into the Electronic Mosquito Destroyer machine. The machine was switched on daily in the morning for 8 hours exposure from 8:00 AM to 4:00 PM, six days in a week for a period of 12 weeks. Group I (Control) animals were kept under identical conditions without exposure to liquid vaporisers. Weight of each rat was recorded weekly and tabulated.

The present study has followed standard criteria for realistic room condition for exposure considering the following information provided by Achmadi UF and Pauluhn J [10]. According to them, conclusion drawn in a workshop organised for standardisation of inhalational studies with regard to generation of test atmosphere, mode and duration of exposure and adequate selection of toxicological end points was that, for risk assessment of low dose and slowly releasing indoor insecticides such as mosquito vaporiser, in a rat model, subchronic inhalational of six hours per day for five days in a week for total 13 weeks administration should be considered as standard exposure.

STATISTICAL ANALYSIS

The data was analysed using SPSS version 21.0. Independent samples t-test was used to compare between group differences. Within group comparison of change in body weight (as compared to enrolment) at different time interval was assessed by paired t-test. A p-value less than 0.05 was considered to be significant.

RESULTS

At baseline, the mean body weight of animals in control and exposure group was 132.38±17.34 and 136.72±15.25 gm, respectively (p=0.656). After two weeks of acclimatisation, statistically there was no significant difference among groups (p=0.456). At 12 week postexposure, the mean body weight of rats in group I was 223.05±44.76 and that of group II was 185.73±41.43 gm, respectively (p=0.165). Data are suggestive of reduced pattern of weight gain in exposed group rats. Weight gain in both the groups of rats was almost similar till 8th postexposure week, after that from 9th week onwards decremental trend in weight was seen in group II till the end of study [Table/Fig-1].

	Group I (Control) (n=6) (gm)		Group II (Experimental) (n=6) (gm)		Statistical significance	
Time	Mean	SD	Mean	SD	t	p
At enrolment	132.38	17.34	136.72	15.25	-0.460	0.656
Acclimatisation Week 1	131.07	16.72	139.80	21.94	-0.776	0.456
Acclimatisation Week 2	147.77	22.80	158.92	25.37	-0.801	0.442
Week 1	171.85	22.77	177.97	19.76	-0.497	0.630
Week 2	181.23	26.79	188.80	20.42	-0.550	0.594
Week 3	191.52	29.79	200.12	25.12	-0.541	0.601
Week 4	193.45	29.22	197.05	29.05	-0.214	0.835
Week 5	204.27	32.34	206.35	35.21	-0.107	0.917
Week 6	213.07	35.60	213.12	36.43	-0.002	0.998
Week 7	217.28	40.00	218.62	39.05	-0.058	0.955
Week 8	221.40	38.22	217.67	41.98	0.161	0.875
Week 9	209.80	32.44	204.38	37.94	0.266	0.796
Week 10	207.52	36.23	192.18	37.74	0.718	0.489
Week 11	222.32	38.09	193.47	39.96	1.280	0.229
Week 12	223.05	44.76	185.73	41.43	1.499	0.165

[Table/Fig-1]: Comparison of Body weight among two groups at different time intervals by Independent Samples t-test.

DISCUSSION

In the present study, subchronic exposure to pyrethroid based mosquito vaporiser fumes adversely affected the body weight of exposed group rats. Body weight of an organism reflects its overall state of metabolism and the capability to maintain its normal growth and development [11]. Weekly observations of body weight helped us to monitor the growth and development of rats. Initially body weight of rats was found to be increased till 8th week, and there after decreasing trend was observed till the end of study which was statistically not significant but the data are suggestive of toxic effect of the pyrethroids on the rats' physiology, especially during later weeks of exposure period. Similarly Sinha C et al., also reported an increasing trend in body weight of adult albino rats after oral beta-cyfluthrin (type II pyrethroid) administration at day 1,7,14 and 28 [12].

Sinha C et al., reported that body weight of rat pups exposed to prenatal, postnatal and perinatal inhalation of pyrethroid decreased significantly [12] but Adjrah Y et al., and Sayim F et al., observed that oral administration of cypermethrin (type II pyrethroid) for 28 days insignificantly reduced the body weight and caused diarrhoea as prominent clinical sign in the rats [13,14]. Sangha GK et al., also noticed that chronic oral administration of cypermethrin results in loose fecal pellets, hyperirritability and significantly decreased body weight as compared to control without affecting food and water intake of rats. In contrast to above finding, present study also did not observed loose fecal pellets but at the end of study, rats started taking less food towards the third month of experiment [15]. It may be due to difference in route of exposure in the present study. Fetoui H and Gdoura R, reported reduced food and water intake in lamda-cyhalothrin treated rats [16]. So, probably in present experiment reduced intake of food could be attributed as cause of reduced body weight instead of diarrhea. This difference can also be attributed to route of exposure. Loss of appetite could be the result of multiple factors. Abdel-Rahman A et al., found that Gulf War Illness Related (GWIR) chemicals caused neuronal cell death in the hypothalamus of exposed animals. Probably feeding centre is located in the hypothalamic region and damage to this could lead to loss of appetite [17].

Tentative hypothesis for weight reduction in the study may be decreased absorption or utilisation of food due to gastrointestinal disturbances caused by altered function of hydrolytic enzymes of small intestine by pyrethroid exposure. Another study reported that the oral administration of single dose of pyrethroid based pesticide resulted in significant changes in the activity of intestinal enzymes that may result in serious disturbances in the intestinal uptake consumption of the composite part of food [6]. Study conducted by Nagarjuna A and Doss PJ helps in explaining decreased absorption of food in pyrethroid exposed rats as they observed that there was hypertrophy of goblet cells, necrotic changes, infiltration and congestion in the duodenum [18].

Another cause for reduced appetite may be associated with damage to pituitary of pyrethroid exposed rats which was already mentioned in study conducted by Fan W et al., observed reduced pituitary weight in allethrin (type I pyrethroid) exposed rats and hypothesised that weight loss could have been due to reduction in growth hormone subsequent to loss of pituitary weight [19].

Similar to the present study, Hasan S and Maheshwari TP who exposed rats to prallethrin vapours 12 hours daily for 180 days did not find any significant variation in body weight [2]. Another study conducted by Kamble VS, also did not find any significant difference in mean body weight between control and exposure (8 hours exposure to allethrin inhalation for 30 days) group rats [20] but Srivastava A et al., noticed significant changes in body weight gain and food consumption in rats exposed to liquid mosquito repellent 8 hours/day for a period of 90 days [21].

Several factors may lead to decrease in weight gain in exposed group like loss of appetite, organ directed toxicities (gastrointestinal, endocrine, central nervous system) and other stressors like change of colony, and anxiety to strange environment.

Limitation(s)

The inhalation rate of the main chemical constituent was not done as the study did not use inhalational chamber.

CONCLUSION(S)

In the present study, an attempt has been made to delineate the effect of subchronic exposure of pyrethroid based mosquito vaporiser fumes on body weight of male albino wistar rats. The exposed group of rats showed reduction of food and water intake which ultimately resulted in decreased weight as compared to control group rats. Several other factors may also be responsible for this reduced weight among the rats, and further study with prolonged period of duration is required.

Acknowledgement

The authors would like to thank Dr. Priyanka Pandey and Dr. Ranjana Sachan whose encouragement, suggestions and support led to successful completion of this work.

REFERENCES

[1] Sharma VP. Health hazards of mosquito repellants and safe alternatives. Curr Sci. 2001;80(3):341-43.
[2] Hasan S, Maheshwari TP. Pyrethroid based mosquito repellent inhalation induced changes in physical activity in albino rats after chronic exposure. International Journal of Scientific and Research Publications. 2013;3(3):2250-3153.
[3] Chandelia S, Dubey NK. Mosquito repellent vaporiser poisoning- Is culprit transfluthrin or kerosene. Indian Pediatr. 2014;51(4):319.
[4] Boratne A, Datta S, Singh Z, Purty A, Jayanti V, Senthilvel V. Attitude and practices regarding mosquito borne diseases and socio demographic determinants for use of personal protection methods among adults in coastal Pondicherry. Indian Journal of Medicine. 2010;1(2):91-96.
[5] Bloomquist JR. Ion channels as targets for insecticides. Annu Rev Pharmcol. 1983;23:163-90. Doi: 10.1146/annurev.en.41.010196.001115.
[6] Khamrakulova M. Enzymatic activity of the intestine in effect of pesticides of pyrethroid group. Medical and Health Science Journal. 2012;10:62-66.
[7] Aldana L, Tsutsumi V, Craigmill A, Silveira MI, Demejia EG. Tocopherol modulates liver tovicity of the pyrethroid cypermethrin. Toxicol Lett. 2001;125:107-16.
[8] Gupta A, Agarwal R, Shukla GS. Functional impairment of blood brain barrier following pesticides exposure during early development in rats. Hum Exp Toxicol. 1999;18:174-79.
[9] CPCSEA Guidelines for laboratory animal facility. Committee for the purpose of control and supervision of experiments on animals. Indian Journal of Pharmacology. 2003;35(4):257-54.
[10] Achmadi UF, Pauluhn J. Household insecticides: Evaluation and assessment of inhalation toxicity: A workshop summary. Experimental and Toxicologic Pathology. 1998;50(1):67-72.
[11] Singh AK, Saxena PN, Sharma HN. Sress induced by beta-cyfluthrin, a thpe-2 pyrethroid, on brain biochemistry of albino rat (rattus norvegicus). Biology and Medicine. 2009;1(2):74-86.
[12] Sinha C, Agrawal AK, Islam F, Seth K, Chaturvedi RK, Shukla S, et al. Mosquito repellent (pyrethroid-based) induced dysfunction of blood-brain barrier permeability in developing brain. Int J Dev Neurosci. 2004;22(1):31-37.
[13] Adjrah Y, Karou SD, Agbonon A, Ameyopoh Y, Souza CA, Gbeassor M. Effect of cypermethrin treated lettuce (Lactuca Sativa) on wistar rat liver. Journal of Applied Pharmaceutical Science. 2013;3(01)128-32.
[14] Sayim F, Yavasoglu NUK, Uyamkgil Y, Aktug H, Yavasoglu A, Turgut M. Neurotoxic effects of cypermethrin in wistar rats: A haematological, biochemical and histopathological study. Journal of Health Science. 2005;51(3):300-07.
[15] Sangha GK, Kaur K, Khera KS, Singh B. Toxicological effects of cypermethrin on female albino rats. Toxicol Int. 2011;18(1):05-08.
[16] Fetoui H, Gdoura R. Synthetic pyrethroid increases lipid and protein oxidation and induces glutathione depletion in cerebellum of albino rats: Ameliorative effect of vitamin C. Hum Exp Toxicol. 2012;31(11):1151-60.
[17] Abdel-Rahman A, Shetty AK, Abou-Donia MB. Disruption of the blood brain barrier and neuronal cell death in cingulated cortex, dentate gyrus, thalamus and hypothalamus in a rat model of gulf-war syndrome. Neurobiol Dis. 2002;10(3):306-26.
[18] Nagarjuna A, Doss PJ. Protein metabolic profiles and histopathological studies in heart tissue of rats during cypermethrin toxicosis. ToxicolInt. 2009;16(2):91-95.
[19] Fan W, Yanase T, Moringa H, Gondo S, Okabo T, Nomura M, et al. Atrzine induced aromatic expression in SF-1 dependant: Implication for endocrine disruption in wilde life and reproductive cancers in humans. Environ. Health Perspect. 2007;115(5):720-27.
[20] Kamble VS. Study of chronic treatment of mosquito repellent liquid inhalation on biochemical constituents of rat. International Journal of Applied Biology and Pharmaceutical Technology. 2012;(4):189-92.
[21] Srivastava A, Srivastava MK, Raizada RB. Ninety day toxicity and one generation reproduction study in rats exposed to allethrin based LMR. J Toxicol Sci. 2006;31(1):01-07.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Anatomy, Hind Institute of Medical Sciences, Mau, Ataria, Sitapur, Uttar Pradesh, India.
2. Additional Professor, Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh, India.
3. Professor, Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh, India.
4. Professor, Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Swati Yadav,
C-17, Dilkusha Colony, Lucknow, Uttar Pradesh, India.
E-mail: swatiyadav67@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Oct 21, 2020
- Manual Googling: Jan 22, 2021
- iThenticate Software: Jan 25, 2021 (6%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Oct 21, 2020**
Date of Peer Review: **Dec 28, 2020**
Date of Acceptance: **Jan 22, 2021**
Date of Publishing: **Apr 01, 2021**