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Serum Biochemical Response to Mosquito Repellent Exposure in Rattus rattus

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Abstract:

Present study was conducted to understand impact of mosquito repellent inhalation on serum biochemical parameters in rat to correlate with various human health hazards.

The allethrin vapour inhalation showed notable effect on serum biochemical parameters such as protein, glucose and cholesterol. When compared with control group, treated group showed overall decrease in serum biochemical constituent's with increase in time of exposure from 8hrs to 24hrs for about 30 days.

Key Words: Mosquito repellent, human health, serum biological parameters, Mosquito

Introduction:

In both urban and rural areas of the country, mosquito populations are a constant threat. These insects serve as vectors for diseases such as malaria, filariasis, and various viral infections, including Japanese encephalitis, dengue, and yellow fever. To mitigate the nuisance and health risks posed by mosquitoes, a variety of repellents are available on the market, including coils, mats, vaporizers, lotions, buzzers, and electrocuting devices. Most of these repellents contain compounds from the allethrin group, which are prevalent in products sold across India, resulting in a wide range of brands. Vaporizers and herbal repellents are particularly popular for combatting mosquito problems and preventing malaria. However, certain chemicals in these repellents can modulate the activity of tissue microsomal mixed function oxidases, which metabolize endogenous substances such as steroid hormones and xenobiotics. This modulation can lead to drug interactions and potential toxicological effects (Hodgson and Levi, 1994; Gibson and Skett, 1994; Hoyumpa and Schenker, 1983).

Mosquito-borne diseases claim many lives annually (Yang et al., 2018). To control mosquito populations, the use of various repellents has become increasingly common (Kamble, 2012). Most repellents use synthetic pyrethroids due to their heat stability, which makes them ideal for use in mat coils and vaporizers containing compounds like allethrin, d-trans allethrin, and S-bioallethrin. When these products are heated or burned, the compounds vaporize without decomposing at temperatures up to 400°C, effectively repelling mosquitoes. Pyrethroid insecticides have been in use for more than 40 years due to their widespread availability, accounting for 25% of the global insecticide market (Kakko et al., 2003; Shafer et al., 2005). Literature indicates significant indoor exposure to pyrethroids in countries like India and the United States (Bateman, 2000; Pankaj and Prahlad, 2004; Narahashi, 2000). However, there is a lack of substantial data or literature on the chronic toxic effects of these compounds on humans (Pankaj and Prahlad, 2004).

Allethrin, a type of pyrethroid, is among the most commonly used insecticides, leading to extensive human exposure over prolonged periods as it is a primary component of many mosquito repellents (Anvita et al., 2006; Tsuji et al., 2002). Due to their lipophilic nature, pyrethroids are known to cause various toxicities (Narahashi, 1996). Allethrin is a synthetic analogue of natural pyrethrum insecticides derived from the flower heads of the plant Chrysanthenium cinerariafollium. It acts by immobilizing insects through poisoning their nervous system (Craig and Stitzel, 1987). In the environment, allethrin biodegrades over time in both indoor and outdoor settings. Its longevity varies from 1-2 hours in the atmosphere to less than 8 hours in an aqueous environment. Eventually, allethrin breaks down into water, CO2, and other carbon-based materials (source). Chemical-induced organ toxicity can manifest as tissue or organ damage and the derangement of cellular metabolism, leading to cell death and, ultimately, organ failure (Gaw et al., 1998).The main site of action of the pyrethroids is the sodium channel, which is kept open for long period of time, causing prolonged sodium current to flow, leading to hyper excitation, of the nervous system. Synthetic pyrethroids like allethrin cause subnormal or super-normal excitability affecting the sodium channel opening time (Cheng et al., 1992). There is pucacity of information concern the effects on human health

due to prolonged and long-term use of allethrin (Mishra and Singh, 2003). Considering this view, present study was conducted to know effect of mosquito repellent on different organs, biochemical changes and histopathology in rat which are correlated to various human health hazards.

Material and method

For the study, a mosquito repellent containing 0.88% allethrin was selected. Adult rats (Rattus rattus), each weighing approximately 200-250 grams, were obtained from a nearby warehouse in Sangola. These rats were divided into three groups, with each group consisting of five individuals housed in steel cages and fed with pelleted food during both winter and summer. The first group was designated as the control group. The second group, or Test Group I, was exposed to 0.88% allethrin inhalation for 8 hours daily. The third group, or Test Group II, was exposed to 0.88% allethrin inhalation for 24 hours daily over a period of 30 days.

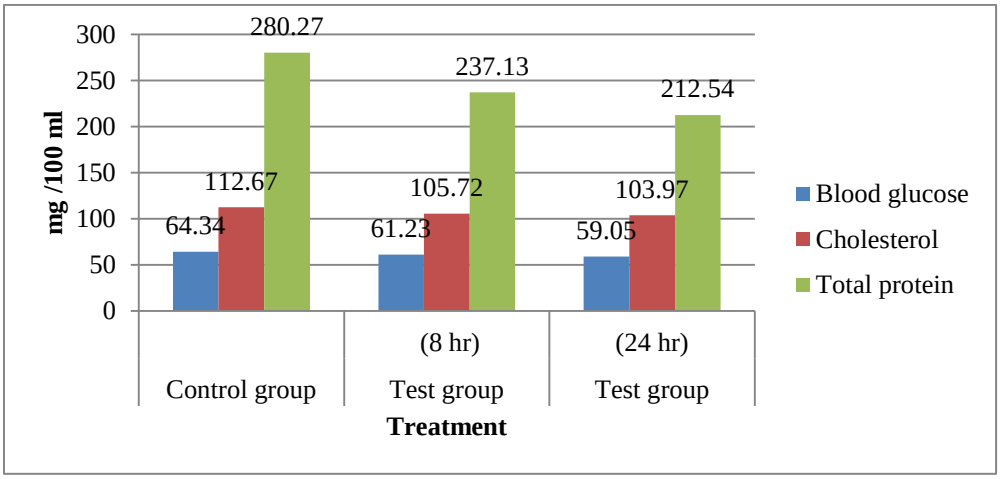
Blood samples for biochemical analysis were collected from all the animals both prior to the commencement of the study and at its conclusion. The pooled samples were used to estimate glycogen levels following De Zwaan and Zandee (1972), total protein levels using the Lowry method (1951), and total lipid content according to Barnes and Blackstock (1973).

Results and Discussion:

Table No. 1: Effect of mosquito repellent inhalation on serum biochemical constituents of rat exposed to allethrin (0.88%) for 30 days.

Parameters	Control group Mg/dL	Test group-I (8 hr) Mg/dL	Test group-II (24 hr) Mg/dL
Blood glucose	64.34	61.23±0.11 (4.83%)	59.05±0.17 (8.22%)
Cholesterol	112.67	105.72±0.23 (6.16%)	103.97±0.2 (7.72%)
Total protein	280.27	237.13±0.12 (15.39%)	212.54±0.22 (24.16%)

Values are expressed as means ± SD. of n=5. Values in parenthesis represents percent



Graph No. 1. Decrease in serum biochemical constituents of *Rattus rattus* after treatment of 30 day exposure to mosquito repellent

In this study, rats were divided into three groups: a control group, an 8-hour exposure group, and a 24-hour exposure group. Each exposure group was subjected to allethrin (0.88%) liquid mosquito repellent for 30 days. The effects of this exposure on serum biological parameters, including blood glucose, cholesterol, and total protein levels, were examined.Initially, the control group had a recorded blood glucose level of 64.34 mg/dL. After 30 days of 8-hour daily exposure (Test group I), there was a 4.68% decrease in blood glucose. The 24-hour daily exposure group (Test group II) showed an 8.22% decrease, with serum glucose levels recorded at 59.05±0.17 mg/100 ml.

The cholesterol level in the initial control group was 112.27 mg/100 ml. For the 8-hour exposure group (Test group I), the cholesterol level decreased to 105.72±0.23 mg/100 ml, which represents a 6.16% decrease compared to the control group. The 24-hour exposure group (Test group II) recorded a cholesterol level of 59.05±0.17 mg/100 ml, a 7.72% decrease.Total protein levels in the initial control group were 280.77 mg/100 ml. After 30 days, the 8-hour exposure group (Test group I) showed a 15.39% decrease in total protein, while the

24-hour exposure group (Test group II) exhibited a 24.16% decrease. The serum glucose levels of total protein for Test groups I and II were 237.13±0.12 mg/100 ml and 212.54±0.22 mg/100 ml, respectively, following 8 and 24 hours of daily exposure.

Gupta et al. (1999) reported that allethrin used in mats and vaporizers can increase the permeability of the blood-brain barrier and cause biochemical changes, posing health risks, particularly at an early age. Narendra et al. (2008) studied allethrin-induced biochemical changes in the erythrocyte membranes of humans, noting a reduction in phosphatidylserine (PS) in human blood, as well as decreases in membrane cholesterol, total phospholipid concentration, and membrane lipid peroxidation. Sharma (2001) reported that repellents can be harmful to human health, with 11.8% of people using various types of repellents complaining of ill health effects. Kamble (2012) observed thickening of the bronchiolar epithelial wall, alveolar wall, septa, and consolidation in alveolar areas in 8-hour and 24-hour allethrin-treated groups of rats over 30 days. Mennon and Hanker (1998) stated that repellents could lead to symptoms such as a runny nose and wheezing, with prolonged use potentially causing corneal damage, asthma, and liver damage. Diel et al. (1999) reported the immunotoxic properties of s-bioallethrin, which inhibits lymphocyte proliferation in a dose-dependent manner. Moya-Quiles et al. (1995) suggested that allethrin could insert and aggregate in the lipid bilayer of model membranes, creating special domains that increase membrane instability and induce a fluidizing effect. They also noted that allethrin modified the bilayer order.

Liu and sun (1987), exposed rats to the mosquito coil smoke for 60 days resulted in focal delectation to tracheal epithelium, metaplasia of epithelial cells and morphological alterations of alveolar macrophages. In present investigation similar might be the case where decrease in biochemical constituents have been observed. Maximum decrease in protein level followed by cholesterol and blood glucose has been observed in both treated groups (8 hrs and 24 hrs) after 30 days of exposure to allethrin (0.88%).

Conclusion:

study reveals that exposure to allethrin (0.88%) liquid mosquito repellent for 8 and 24 hours over a period of 30 days has significant effects on the serum biological parameters of rats, including blood glucose, cholesterol, and total protein levels. Both 8-hour and 24-hour exposure groups experienced notable decreases in these parameters compared to the control group. Specifically, the 24-hour exposure group showed a more pronounced reduction in serum glucose, cholesterol, and total protein levels.

The findings are supported by previous research indicating that allethrin and similar compounds can cause biochemical and physiological changes, leading to potential health risks. For instance, Gupta et al. (1999) and Narendra et al. (2008) documented changes in blood-brain barrier permeability and erythrocyte membrane composition. Studies by Sharma (2001) and Kamble (2012) highlighted the adverse health effects of prolonged exposure to repellents, including respiratory and systemic toxicity. Moreover, research by Mennon and Hanker (1998) and Diel et al. (1999) emphasized the broader health implications of repellent use, including immune system suppression and chronic respiratory issues. Moya-Quiles et al. (1995) suggested that allethrin's interaction with lipid membranes could lead to increased membrane instability and altered cellular functions.

Overall, the study underscores the need for cautious use of mosquito repellents containing allethrin and further investigation into their long-term health impacts. The results also highlight the importance of developing safer alternatives and implementing robust pest management strategies to minimize potential human health risks.

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