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The impact of kerosene and naphtha fumes inhalation on lung tissue in rats.

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ABSTRACT

This study aimed to evaluate the effects of inhaling kerosene and naphtha vapors on rats' respiratory systems. It included 30 male rats, divided into two separate groups; in the first group, rats were exposed to Kerosene vapors for 6 hours each day for 30 and 45 days. In the second group, rats were exposed to naphtha vapor for 6 hours each day, with differing durations of either 30 or 35 days. An investigation of lung tissues collected from male rats exposed to kerosene vapors for 30 days revealed vascular congestion, bleeding, and thickening of the walls separating the air sacs. Rats exposed to kerosene fumes for 45 days exhibited bleeding between pulmonary tissue and a modification of the typical structure of the alveoli. Lung histology in male rats exposed to 30 days of naphtha fumes showed interalveolar septal thickening and congestion within the lung tissue's blood vessels. Lung histopathology from male rats who inhaled naphtha vapors for 45 days revealed alveolar breakdown and bleeding in the lung tissues. This study concluded that inhaling kerosene and naphtha fumes alters the lung's histological structure and negatively influences the respiratory system.

Key words: Volatile organic compounds, Petroleum products, Lungs.

1. Introduction

Refineries and petroleum companies emit hazardous pollutants into the atmosphere (McDonald et al., 2018). Najaf oil refinery is an essential source of petroleum products (such as naphtha, Kerosene, petrol oil and heavy black oil) for Najaf city and its surrounding areas. It serves the local demand for these products and supplies electrical stations, the industrial sector, and other purposes (Heider, 2022).

Petrol contains several dangerous compounds, including BTEX, which stands for benzene, toluene, ethylbenzene, and xylene, which are volatile aliphatic and aromatic hydrocarbons (Kodidala et al., 2020). Furthermore, various processed petroleum compounds negatively impact numerous human biological functions (Ajeel et al., 2021). According to Al-Hulfi et al. (2022), liver enzymes and central nervous system hormone production are both affected by contaminants coming from petroleum products.

In addition, the many negative short- and long-term impacts on human health caused by volatile organic compounds are gastrointestinal issues, respiratory tract irritation, central nervous system dysfunction, narcosis, implications on growth, and cancer risk (Chaurasia and Tiwari, 2017). The neurological depressant naphtha, when inhaled, is known to irritate the mucous membranes, eyes, and skin of humans (Hathaway and Proctor, 2014). Air pollution induces the immune system to secrete white blood cells and macrophages, according to research by Hiraiwa and van Eeden (2013). These pollutants primarily

cause leukaemia and other severe disorders of the blood, lung cancer, allergy pneumonia, cardiovascular effects, immune system depression, neurological diseases, and skin diseases (Dantes et al., 2016; Vogelmeier et al., 2017). This study examined the adverse effects of inhaling kerosene and naphtha fumes on rat lungs.

2. Materials and methods

Experimental animals

Forty adult males (Wistar albino) rats ranging in weight from 150 to 200 g and with an average age of 2.5 to 3 months were involved in the research. The animal house at the University of Kufa's Faculty of Science provided the usual circumstances for the animals, including a temperature range of 25–28 degrees Celsius, a 12-hour light-dark cycle, and access to water and a standard meal. University of Mosul Ethical Approval No. Um.VET.2021.5 was performed in this study. A central council for ethical issues at the College of Sciences of Kufa has previously authorized all animal studies using these protocols.

Exposure to kerosene and naphtha fumes

This study, inhalation was used as the exposure method. The exposure chambers used for the animal groups' housing were 150 cm x 90 cm x 210 cm. The animals were introduced to the vaporizing fumes from two 1000 ml cans with large holes, each holding 500 ml of liquid Kerosene. The cans are set up in the exposure chamber. Naphtha fumes followed the same protocol. Both studies involved subjecting animals to vapors for 30 and 45 days, six days a week, from 9:00 a.m. to 3:00 p.m. Liquid naphtha and the AL-Najaf petroleum refinery in Najaf, Iraq, acquired Kerosene. A modified exposure approach through nasal inhalation has been detailed (Uboh, 2005).

Experimental design

Two groups of fifteen rats each were randomly assigned to each of the two studies using thirty male albino rats. The first experiment had three groups of five rats each: a control group (G1), one exposed to kerosene vapors for 30 days at a rate of 6 hours per day, and a third subjected to the same amount of fumes for 45 days. In the second trial, five-rat groups were formed: G1, the control group; G2, the group that was exposed to naphtha vapours for 30 days at a rate of 6 hours per day; and G3, the group that was subjected to 45 days of the same rate of 6 hours per day.

Histological studies

Techniques for Preparing Tissue Sections Following the protocol outlined by Bancroft and Stevens (1999), the tissue slices were produced. Before being processed and sectioned at 4-5 μm thickness, lung tissues were fixed in ten per cent phosphate-buffered formaldehyde for 72 hours. After staining with haematoxylin and eosin (H&E), the slices were prepared for light microscopy by mounting them in a D.P.X. medium.

Examination and microscopic photography

The slides were examined under 40 x magnifications using an Olympus compound light microscope to identify histopathological and developmental changes. Images of tissue sections were captured using a light microscope.

3. Results

The histological examination of male rats reveals lung exposure to kerosene fumes for 30 days, resulting in blood vessel congestion, hemorrhage within the respiratory tissues, and thickness of the interalveolar septa. (Figure 1 B). After histological assessment, the lungs of male rats exposed to kerosene vapors for 45 days exhibited bleeding in the pulmonary tissues and disruption of the standard structure of the alveoli (Figure 2B).

The histological examination of the lungs revealed normal bronchioles, epithelia and alveoli in the control male rats (Figure 3A). The histological section of the lungs of male rats exposed to naphtha fume for 30 days showed congestion inside the blood vessel within the pulmonary tissue, thickening interalveolar septa (Figure 3B). Histological section of the lungs of male rats exposed to naphtha fume for 45 days revealed hemorrhage between the lung tissues and collapsed alveoli (Figure 4B).

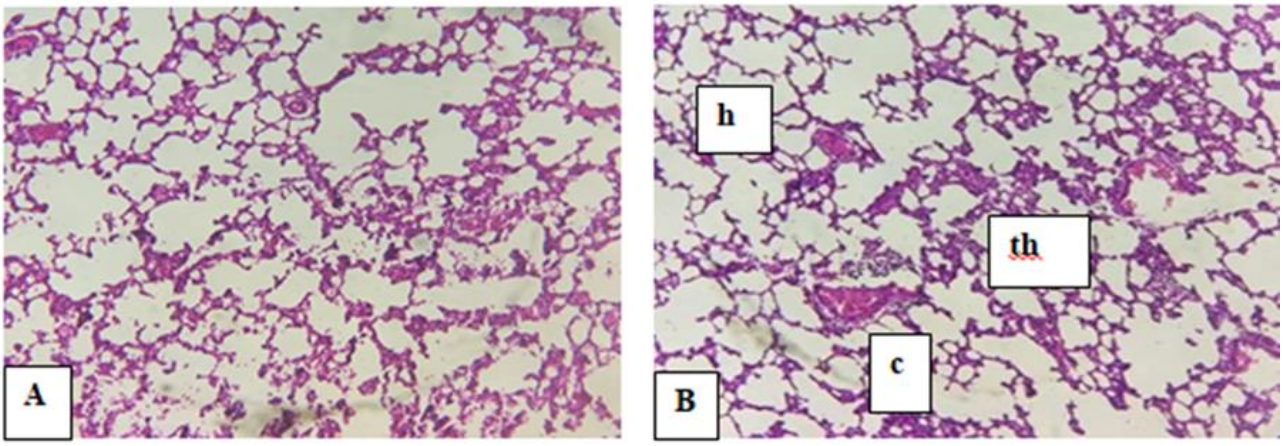

Fig .1 Lung tissue histopathological changes. G1 (control) lung tissue of male albino rats not exposed to kerosene fume; B: G2 rats exposed to kerosene fume at 30 days showing c: congestion occurred inside the blood vessel, h: hemorrhage within the pulmonary tissue, th: thickening of interalveolar septa. The lung tissues were examined under a microscope at x100 magnification after being stained with H&E stain.

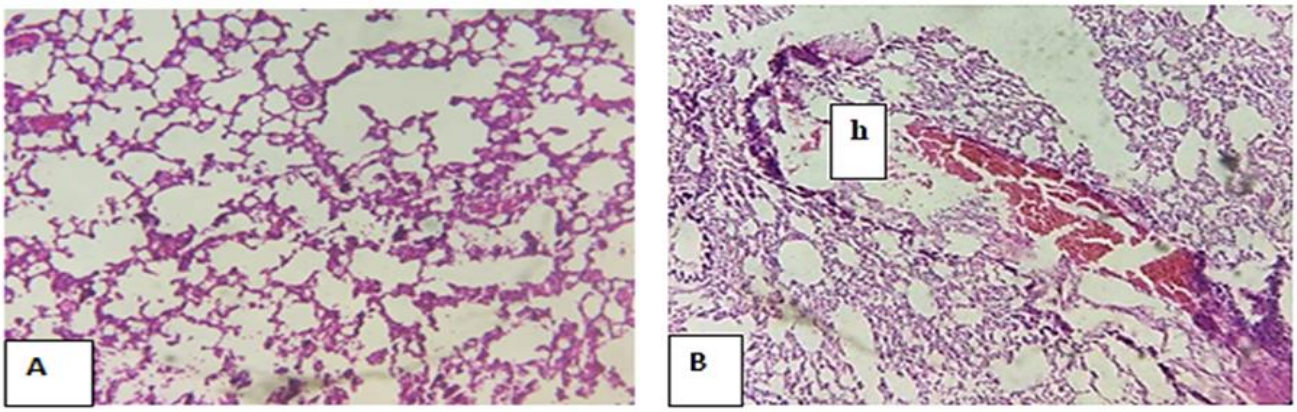

Fig. 2 Lung tissue histopathological changes. A: G1 (control) lung tissue of male albino rats not exposed to kerosene fume; B: G3 rats exposed to kerosene fume at 45 days showing h: hemorrhage between pulmonary tissues as well as extravasated red blood cells in the interalveolar space and loss of standard architecture of alveoli. The lung tissues were examined under a microscope at x100 magnification after being stained with H&E stain.

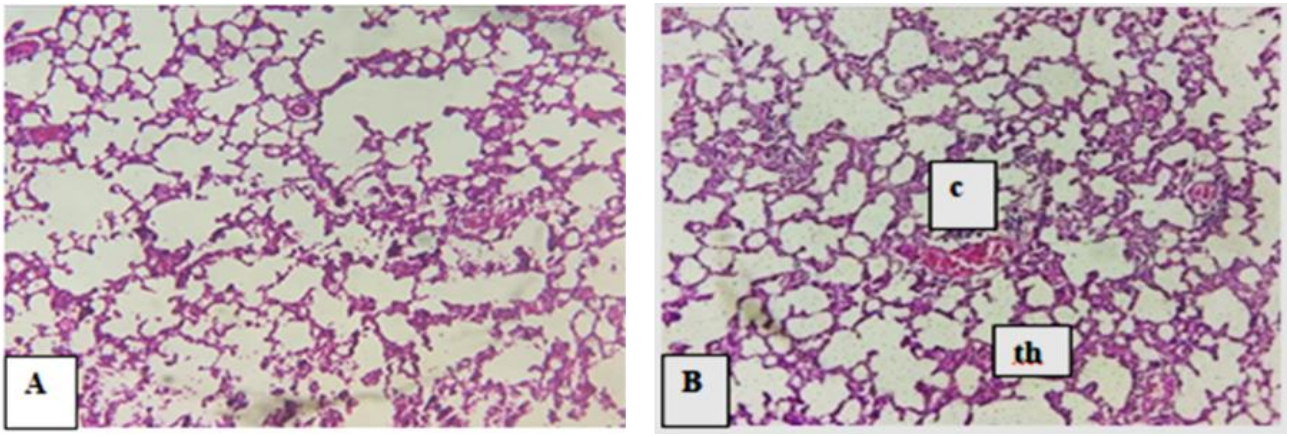

Fig. 3 Lung tissue histopathological changes. A: G1 (control) lung tissue of male albino rats not exposed to naphtha fume. B: G2 rats exposed to naphtha fume at 30 days showing c: congestion occurred inside the blood vessel within the pulmonary tissue, th: thickening of interalveolar septa. The lung tissues were examined under a microscope at x100 magnification after being stained with H&E stain.

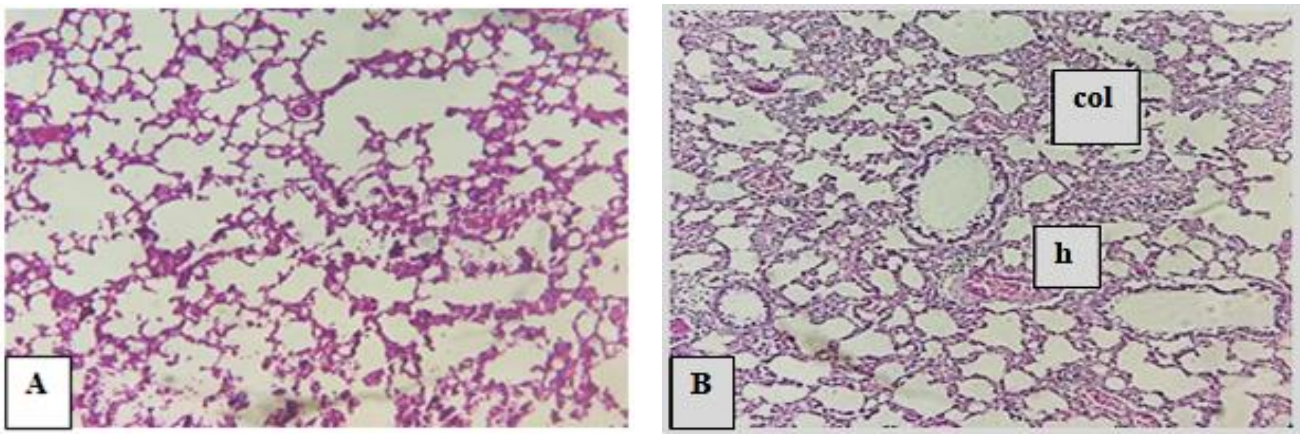

Fig 4. Lung tissue histopathological changes. A: G1 (control) lung tissue of male albino rats not exposed to naphtha fume. B: G3 rats exposed to naphtha fume at 45 days showing h: hemorrhage between the lung tissues; col: collapsed alveoli. The lung tissues were examined under a microscope at x100 magnification after being stained with H&E stain.

4. Discussion

A microscopic examination of lungs exposed to kerosene fume for 30 days revealed vascular congestion, bleeding inside the lungs, and thickening of the interalveolar septa (Figure 1, B). A possible reason is that our lungs are the first organs affected when we inhale fuel fumes. Ezzat et al. (2011) found that the hydrocarbons of petrol are easily absorbed by the lungs because of the respiratory tract's high accessibility and high absorption surface, in addition to the fact that it is the primary method of exposure (Ahmed, 2001). Fumes irritate and disrupt the air in the lungs, alveoli, and lungs.

The inhalation of petrol vapors has been linked to organ problems, including the lungs, hearts, skin, and kidneys. It also has many harmful effects on genetic material, causing mutations, impairing the immune system, and perhaps leading to the development of cancer and neurological damage (D'Azevedo et al., 1996). A study conducted by Prasad et al. (2011) found that being exposed to petroleum hydrocarbons negatively affects type II pneumocytes, resulting in reduced synthesis of surfactant and collapse of the alveoli; this leads to a mismatch between ventilation and perfusion and a drop in oxygen levels in the blood (hypoxaemia). Consequently, this results in inflammation in the spaces between cells, bleeding in the air sacs of the lungs, accumulation of fluid in the air sacs, death of the bronchial tubes, increased blood flow, and death of blood vessels. These changes in the tissue structure may be caused by a combination of mechanisms that involve the suppression of protective substances that break down harmful molecules, increased production of reactive oxygen and nitrogen, and inflammatory reactions.

Animals exposed to kerosene fumes for 45 days showed histological lung changes, including alveolar architecture loss and bleeding between lung tissues (Figure 2B). This finding agrees with what Akpan et al. (2014) found mice exposed to petroleum had lung histological changes. Toxic or sub-lethal effects of xenobiotics are likely to manifest first in the lungs, especially in the case of fumes or vapors that are mainly inhaled by the nose and then directed to the lungs since the skin and lungs are the primary entry points for these environmental contaminants. In addition, Hanachi (2002) found that Benzo(a)pyrene caused histological changes in the lungs of muscle tissue samples.

Volatile organic compounds (V.O.C.s) that are harmful do not usually cause immediate toxicity but have cumulative adverse health effects over time. Studying V.O.C.s and their impacts is intricate due to the typically low concentrations and the gradual onset of symptoms. Inhalants are quickly absorbed into the lungs and rapidly induce a modified mental state. However, the effects are short-lived, lasting only around 5 to 15 minutes. The precise mechanism of action for volatile substances is not yet known. Still, there are common theories suggesting a general

slowing down of axonal ion channel transport and an enhancement of hyperpolarisation of gamma-aminobutyric acid receptors (A El-Nouri, 2009). Xu et al. (2015) found that when mice were exposed to Rocket kerosene through inhalation, it caused lung damage. The researchers suggest that oxidative damage and an inflammatory reaction may be the underlying reasons for this toxicity. Collectively, the findings indicate that inhaling Rocket kerosene can have detrimental consequences on the lungs of mice, perhaps heightening the likelihood of developing pulmonary disease.

The microscopic analysis of the lung exposed to naphtha emissions for 30 days revealed congestion inside the blood vessels in the pulmonary tissue and thickening of the interalveolar septa (Figure 1, B). The findings of this study align with the results reported by Azeez et al. (2012), which highlighted that exposure to petroleum hydrocarbons by inhalation increases the chance of developing pulmonary dysfunction. This is linked to oxidative stress. In their study, Sprong et al. (1998) demonstrated that prolonged exposure to petrol resulted in significant damage to the lungs' structure, including alveolar destruction, shedding of bronchiolar epithelia, and loss of cell membrane integrity.

Several hydrocarbons in Kerosene, including hexane, naphthalene, octane, and phenanthrene, are toxic to humans. Aspiration pneumonia is the most serious adverse effect. Hydrocarbon aspiration (H.A.) can lead to severe lung illness by triggering an inflammatory reaction, bleeding exudative alveolitis, and impairing surfactant function. Additional consequences in the lungs may involve pneumothorax, pneumatocele, or bronchopleural fistula. We searched for a case of bilateral hemorrhagic pleural effusion in adults that occurred as a result of ingesting Kerosene. However, as far as we know, there have been no reported cases of this nature today (Levin and Lilis 2008).

Microscopic examination of the airways of rat males exposed to naphtha fumes for 45 days showed hemorrhage inside the lung tissues, enlargement of vessels for blood, and collapsed air sacs (Figure 2B). In the study conducted by Sambo et al. in 2019, the lung tissue exhibited histological alterations, including oedema, exudates within the alveoli, and infiltrating of lymphoid cells surrounding the terminal bronchioles in rats subjected to petrol vapor within an exposure chamber. A study by Ikenna (2023) found that extended exposure to diesel emissions resulted in mild lung congestion in the pulmonary interstitium. Additionally, the volatile structure of these products makes the stated chemicals easily present in the air, which can lead to direct inhalation and exposure. Within a confined space, the concentration of volatile petrochemical compounds can become extremely high, potentially causing unconsciousness or even death due to respiratory illness (Chilcott, 2007).

Refinery workers are at greater risk of developing chronic bronchitis, asthma, and chronic obstructive pulmonary disease (COPD) due to the nature of their work (Singh et al., 2019). Chemicals like benzene, formaldehyde, acetaldehyde, phenol, ethylbenzene, and xylene are among the harmful air pollutants released by the industry. Inorganic compounds like hydrogen chloride and hydrogen cyanide are also released, as are reduced sulphur compounds like carbon disulphide and metals like arsenic, beryllium, cadmium, chromium, and cobalt. Specifically, these pollutants are linked to the onset of cancer, hypersensitivity, respiratory infections, cardiovascular problems, immune system suppression, neurological disorders, and diseases of the skin (Martoni, 2018). The findings of this research indicate that the inhalation of Kerosene and naphtha induces changes in the histological structure of the lungs.

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