African Journal of Basic & Applied Sciences 1 (1-2): 1-8, 2009
ISSN 2079-2034

Toxicity of Particulate Atmospheric Pollution on Installs Respiratory Rabbit

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Abstract: Les études épidémiologiques démontrent une corrélation entre l'exposition aux particules (P.M.) et les affections respiratoires. Les principaux effets des polluants atmosphériques particulaires sur la santé concernent essentiellement l'appareil respiratoire. Ces manifestations résultent généralement, soit d'une toxicité directe des polluants, soit d'une fragilisation des mécanismes de défense de l'organisme vis à vis des agressions bactériennes, virales ou allergiques. Nous avons évalué la composition chimique et testées des particules d'origine industrielle sur le lapin et on a étudié leur l'impact sur le parenchyme pulmonaire et trachéal en pratiquant des coupes histologiques. D'après les observations microscopiques, on a remarqué des parenchymes pulmonaire et trachéal très atteint avec une accumulation des particules industrielles. Notre étude met en évidence cette relation entre la durée de l'exposition aux particules industrielles et les différentes altérations histologiques observées. En effet, l'examen histologique du parenchyme pulmonaire nous révèle qu'il est affecté rapidement dés 3 jours d'exposition et cette toxicité augmente en fonction du temps. Pollution atmosphérique particulaire, toxicité, lapin, appareille respiratoire. The epidemiological studies show a correlation between l' exposure to the particles (PM) and the respiratory affections. The principal effects of the particulate atmospheric pollutants on health relate to primarily the breathing apparatus. These demonstrations generally result, either of a direct toxicity of the pollutants, or of an embitterment of the mechanisms of defence of the organization with respect to the bacterial, viral or allergic aggressions. We evaluated the chemical composition and tested particles of industrial origin on rabbit and one studied their impact on the pulmonary parenchyma and tracheal as a practitioner of the histological cuts. According to the microscopic observations, one noticed parenchyma's pulmonary and tracheal very reached with an accumulation of the industrial particles. Our study highlights this relation between the exposure time to the industrial particles and various histological deteriorations observed. Indeed, the histological examination of the pulmonary parenchyma reveals us that it is affected quickly dice 3 days of exposure and this toxicity increases according to time.

Key words: Particulate atmospheric pollution · Toxicity · Rabbit · Install respiratory

INTRODUCTION

Many existing substances in the air can penetrate in the organization by respiratory tract and reach the circulating blood which will transport them in various fabrics and bodies where their effects will be exerted. The particles and the aerosols settle in various areas of the respiratory tract according to their size. The large particles, solids or liquids, of higher diameter 10µm are generally stopped on the level of the nasopharynx. Those whose diameter lies between 3 and 10µm ("thoracic" fraction) reach the intermediate tract (trachea, bronchi, bronchioles) and can be mainly gone up jusqu' to the mouth by the carpet mucocilliaire, those whose diameter is lower than 3µm will go until the cells ("alveolar" fraction) or they can be phagocyte by the macrophages eliminated in secretion bronchial, or on the contrary to kill the macrophages in pulmonary fabric. In this last case they can be responsible, especially in professional environment, lesions fibrosantes and effects cancerogenic [1-3].

Heavy metals and the metalloids present in the air in the form of fine dust settle along the respiratory tracts. The largest particles are stopped on the level of the higher respiratory tracts, to be then swallowed and to arrive in the digestive system; finest energy to the air cells [4,5].

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This dust is also deposited on the grounds, water and the plants and can seriously contaminate the food chains by bio-accumulation. The effects generated by these pollutants are also varied and depend on the chemical state under which they are found (metal, oxide, salt,) [6-8].

The principal short-term effects of the atmospheric pollutants on health relate to primarily the breathing apparatus [8,9,4]. These demonstrations generally result, either of a direct toxicity of the pollutants, or of an embitterment of the mechanisms of defence of the organization with respect to the bacterial, viral or allergic aggressions [10,11]. Nevertheless, other apparatuses are also concerned with the effects of atmospheric pollution like the cardiovascular apparatus, the liver and the kidneys [12,13].

Epidemiological studies brought back causal links between the exposure to high concentrations of particles of the ambient air and the increase in morbidity at the individuals having respiratory problems. The leucocytes polyneutrophiles (PN) are often present in the respiratory tracts of the people exposed to particles. During the stimulation of the PN by the polluting particles, they release from the reactive species of oxygen (ROS), which involves deteriorations and lesions of fabrics [14]. Blood plays a big role in the transport of these particles of the air cells towards the other bodies such as the liver for the detoxication, fat fabrics for accumulation or storage and the kidney for the excretion [15,16].

MATERIALS AND METHODS

The Metal Particles Used: The metal particles used in our study were collected with in steelworks of El-Hadjar in Annaba (Algeria). In precondition to the research of the effects of the dust rejected by the steel-works of the steelworks, the study first of all related to the chemical analysis of this dust. Those were proportioned by the technique of the atomic absorption. This analysis determined the presence of 07 heavy metals indicated in Table (1). Some of these heavy metals have carcinogenic potentialities [17,18].

The whole of the results shows well that a true atmospheric pollution is generated by the two units with the steelworks of El-Hadjar with Annaba. The elements which constituted this dust are metals heavy. The recorded contents very high are compared with the international standards; the contents largely exceed the standards in force [19].

Table 1: Chemical composition of the particles tested

Elements rejected	Steel-works 1 (ppm)	Steel-works 2 (ppm)	Total (ppm)
Zinc (Zn)	240	480	720
Lead (Pb)	24	62,4	88,4
Chromium plate (Cr)	10	12	22
Nickel (Ni)	1,2	1,3	2,5
Manganese (Mn)	320	540	860
Iron (Fe)	3000	3600	6600

Treatment of the Animals: One used the rabbit hare of the species Europeus, pertaining to the family of the "Ceparides" and the order of the "lagomorphs". The manpower being of 28 adult buck rabbits, distributed in conventional cages at a rate of 7 rabbits per cage. The rabbits are nourished lettuces, of carrot and barley flour. The rabbits were acclimatized to the conditions of the animally during one week before the beginning of the experiments. The rabbits are exposed to a quantity of 2 g dust metal, each day per same hour during 20 minutes.

Treatment of the Animals: The cages of rabbits, during the exposure to dust are insulated and placed in a hermetic enclosure to be sour that the rabbits breathed the particles well. During the exposure to the metal particles, one withdraws food, water and the litter to make sure that dust will not be introduced by rabbits.

Taking Away of the Bodies: It is with the assistance of a veterinary surgeon that the sacrifice of rabbits was carried out. After dissection one recovers the lung, to weigh it. One takes also the trachea. A fragment from 2 to 3 cm of each body is taken and directly fixed in the liquid of alcoholic Bouin for a histological study. The observation of the cuts are made with a photo microscope Olympus BH2 provided with an ocular micrometer.

RESULTS

Follow-up of the Weight of the Lung: Table 2 highlights a disturbance of the weight of the lung of rabbit exposed to the metal particles compared to the witness. The weight increases after 3 and 7 days of exposure and decreases after 21 days of exposure.

Examination of the Histological Cuts of the Pulmonary Parenchyma

Histological Examination after 3 Days of Treatment: The Figure (1) illustrate a distension alveolar with a thinning of the alveolar partitions, a vascular congestion and a light inflammatory reaction

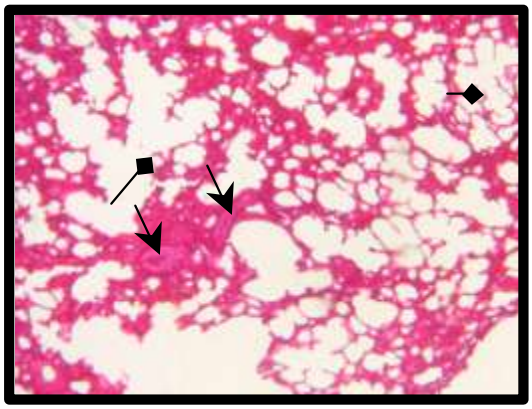

Fig. 1: Aspect of pulmonary fabric observed under the optical microscope (enlargement X 200). Pulmonary fabric observed 24 hours after the stop of the pulmonary treatment during 3 days.
Distension of the alveolar wall
Vascular congestion

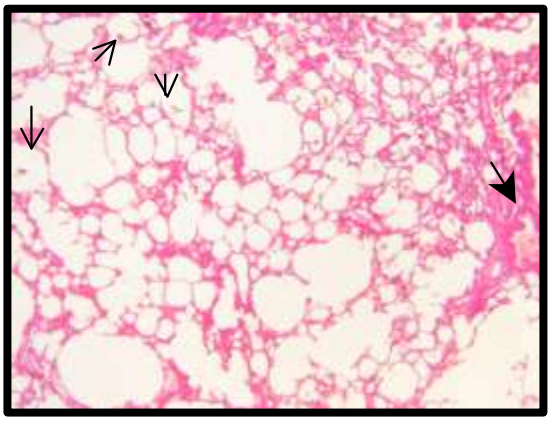

Fig. 2: Aspect of pulmonary fabric observed under the optical microscope (enlargement X 400). Pulmonary fabric observed 24 hours after the stop of the treatment during 7days.
Accumulation of dust
Vascular congestion

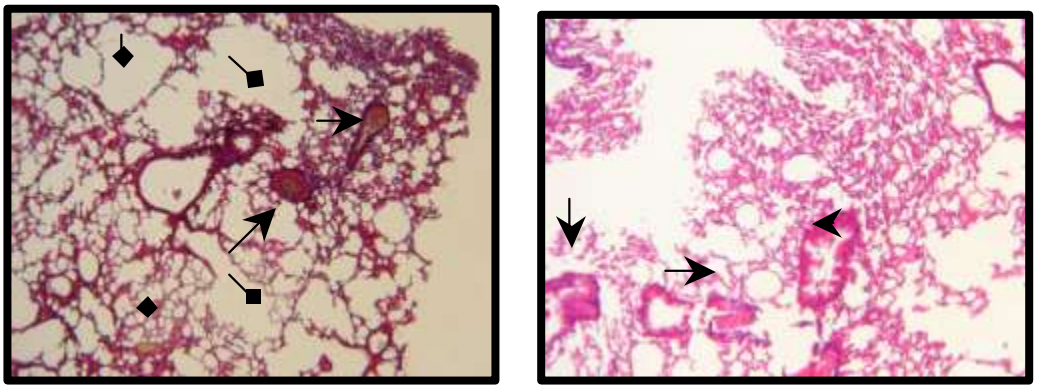

Fig. 3: Aspect of pulmonary fabric observed under the optical microscope 24 hours after the stop of the treatment during 21 days (enlargement X 200).
Distension of the alveolar wall
Vascular congestion
Necrosis cellular
Dilated faded bronchiole

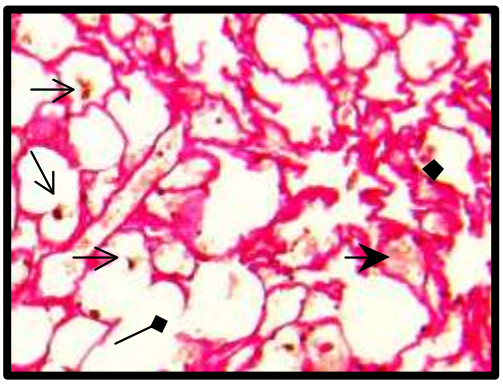

Fig. 4: Aspect of pulmonary fabric observed under the optical microscope 24 hours after the stop of the treatment during 21 days (enlargement X.400).
→ Accumulation of the metal particles.
→◆ Distension of the alveolar wall
→ Vascular congestion ◆ Necrosis cellular

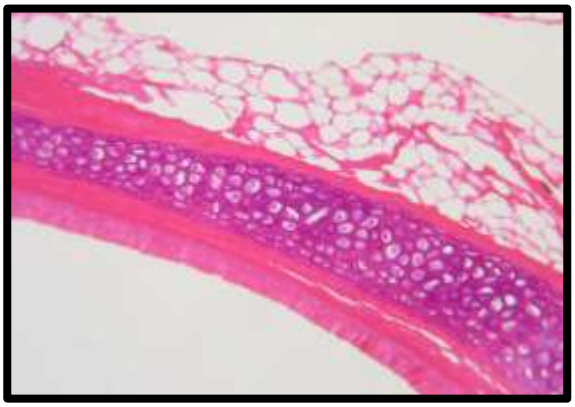

Fig. 5: Aspect of the trachea fabric observed under the optical microscope (enlargement X.200). Trachea observed 24 hours after the stop of the treatment during 3days. (The beginning of the alteration of the trachea)

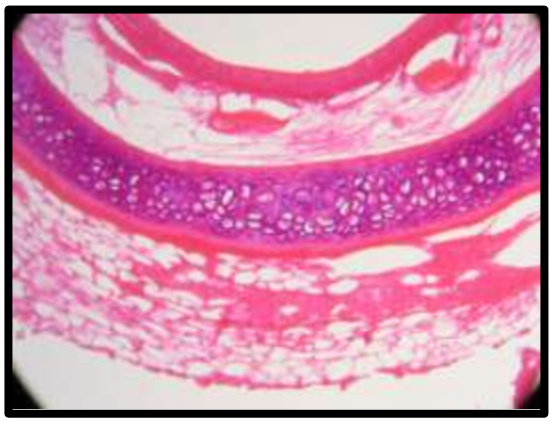

Fig. 6: Aspect of the trachea fabric observed under the optical microscope (enlargement X.200). Trachea observed 24 hours after the stop of the treatment during 7days.
Adventitious faded
Faded Chorion
Faded trachea fabric

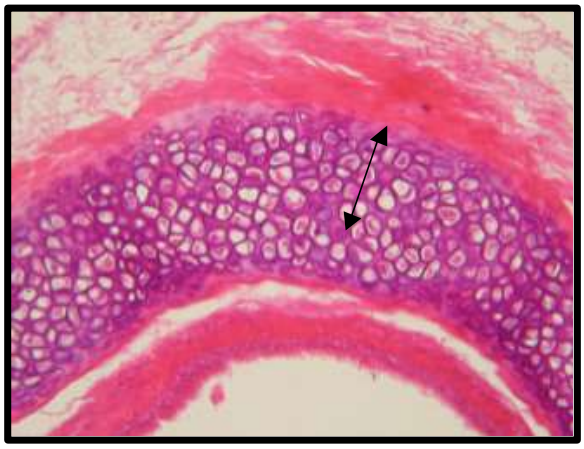

Fig. 7: Aspect of the trachea fabric observed under the optical microscope 24 hours after the stop of the treatment dust of the complex during 21 days (enlargement X.400).
Adventitious faded
Faded Chorion
Faded trachea fabric
Increase thickness of the cartilage

Table 2: Follow-up of the weight of the lung according to the time of treatment (average + standard deviation; n= 28).

Weight of the lung (g)Witness	After 3 days of exposure	After 7 days of exposure	After 21 days of exposure
7.39±0.21	8.21±0.19**	7.84±0.25	5.90±0.25***

** Very significant Difference p; *** Highly Significant Difference pp<0.001

Histological Examination after 7 Days of Treatment: The Figure (2) reflects the same aspect that has 3 days of treatment but more marked: a thinning of the walls with a more important alveolar distension; one notices also important inflammatory reactions and vascular congestions with accumulations of the metal particles in the pulmonary parenchyma.

Histological Examination after 21days of Treatment: The Figure (3) reveals a pulmonary parenchyma very reached; with important inflammatory reactions, very important alveolar distensions and final bronchioles dilated with necrosis. The Figure (4) very clearly illustrates the deposits of the metal particles on the level of the pulmonary parenchyma and the induced inflammatory reactions.

Examination of the Histological Cuts of the Parenchyma Tracheal

Histological Examination after 3 Days of Treatment: The Figure (5) watch of the tiny inflammatory reactions after 3 days of treatment with a deposit of the metal particles on the level of the adventitious one.

Histological Examination after 7 Days of Treatment: The Figure (6) illustrates important inflammatory signs on the level of the chorion and epithelium tracheal.

Histological Examination after 21jours of Treatment: The Figure (7) show a parenchyma tracheal very reached: there is a destruction of the epithelium tracheal and adventitious thus q' an increase in the size of the cartilage.

DISCUSSION

There exists very little of study concerning the risk on the human health in relation to the industrial wastes composed of several elements. The data of the existing literature relate to primarily the effects of each metal with share; the most studied are mercury, cadmium and lead. The particles or suspended dust related to the human activity come mainly from automobile transport and industrial activities. Their sizes and their compositions are very variable. The particles are often associated with other pollutants [20,9].

The effects of its particles differ according to their sizes (granulometry). The particles penetrate more or less deeply in the pulmonary tree. The finest particles can,

with relatively low concentrations, to irritate the lower respiratory tracts and to deteriorate the respiratory function as a whole. Certain particles have mutagen and carcinogenic properties. In the short run, these particles cause disturbances of the phagocytes' defence of the respiratory tract, ignitions local and hyper reactivity [21,22].

The samples of the parenchyma's pulmonary and tracheae after three days of treatment with the metal particles, cause inflammatory reactions; this could be a first biological answer due to the presence of xenobiotic to strong concentration. These signs seem to worsen according to time; these results are in agreement with work of Voisin *et al.,* [23] and Nemmar *et al.,* [24].

Moreover, after 21 days, our resulted reveal important inflammatory signs on the level of the trachea and irritations of pulmonary fabric more marked with degenerative lesions of final bronchioles and lesions of pulmonary fabric of the emphysematous type by imbalance of the balance anti-protease protease related on the action inhibiting of the free radicals of oxygen on l'á L antitrypsin and to the release of elastase granulocytes and macrophages [23].

Thus dust goes penetrated with the air inspired, especially by the nose and the sufficiently small particles of size (diameter lower than 3µm) penetrate deeply in the breathing apparatus and can reach the air cells. Once absorbed by the organization by inhalation, dust is distributed by blood to different the target bodies [25-27].

Our results concerning the toxicity of the metal particles on l' breathing apparatus (lung and trachea) are in perfect agreement with those quoted above by the literature.

CONCLUSION

Air is essential to all the living beings; there is air pollution when the presence of a foreign substance or an important variation in the proportions of its components is likely to cause a harmful effect or to create harmful effect or gene [28-30].

The made up ones absorptive on the particles seem to be responsible for most of the toxic effects observed [31-33].

Heavy metals are well-known environmental pollutants for their particularly dangerous effects for the human health. Because of their broad use in much of industrial branches, they are present everywhere in the air, water and the ground. The exposure to the contaminants can deteriorate the immunocompetence, by increasing by this fact the susceptibility of the disease. However the immune system of the mammals is important for maintains good health [3,34,5].

Former studies made elsewhere in the world on animals of laboratory established a etiologic relation between the exposure of the atmospheric pollutants and the respiratory affections [35,36,6,7].

The appreciation of atmospheric pollution is based in practice on the metrology of certain parameters like strong acidity, the black smoke and certain specific pollutants like the sulphur dioxide and dioxide nitrogen. It is thus limited in these analytical possibilities and does not allow taking into account the interactions of the pollutants between them [37-39].

Our study highlights this relation between the exposure time to the metal particles and various histological deteriorations observed. Indeed, the histological examination of the pulmonary parenchyma reveals us that it is affected quickly dice 3 days of exposure and this toxicity increases according to time.

These disorders are the result of cellular and biochemical deteriorations complex which are initiated on the level of the respiratory mucous membrane. These deteriorations, started by the daily repetition of external aggressions, are self-sustained by the pathological diversion of the local and general mechanisms of defense [40,18,36,41].

Certain particles are inoffensive different highly toxic and carcinogenic ones. The impact goes from simple gene olfactive to an irritation or reduction in the respiratory capacity, until risks of carcinogenic effects [3,42,40,7,6].

Metals finally, represent a category of particular molecules. Some are purely toxic for the living beings; d' others, essential with l' organization and with l' maintenance of the biological functions, last a certain threshold of concentration, generate toxic effects on l' organization. In both cases, their accumulation with l' interior d' an organization is likely to start a defence reaction, which will be used as biomarquor for this type of contamination.

In conclusion, the dust rejected by the steelworks records very high rates which exceed by far the international standards limited by the O.M.S have the capacity to deteriorate the cellular functions and to accumulate in target fabrics.

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