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Bio-Indication of Air Quality in the Annaba City (East of Algeria)

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Abstract: The town of Annaba (East of Algeria) is characterized by a very polluted atmosphere, which became a dangerous for the fauna and the plants, the regional planning and environment ministry has installed an of air quality control network , baptized SAMASAFIA which is composed of 4 stations of air quality monitoring: Station 1 (Annaba), station 2 (El Bouni), station 3 (Sidi Amar), station 4 (Airoport). This study consists to use the pollen as bio-indicator of pollution. The pollen of *Malus communis* (Rosaceae) and *Phoenix dactylifera* (Arecaceae), have been exposed to air during 24 h inside the 4 stations of SAMASAFIA. The analysis of SAMASAFIA showed the existence of pollution caused especially by the dust (78 μ g m^{-3} 24 h^{-1}) notably at EL Bouni sites. The results showed after 24 h of exposure a considerable decrease in germination percentages at EL Bouni (87-37%) with a loss of 50%. This investigation has permited to combine data of the physico-chemical analysis of network SAMASAFIA with the biological data of the pollen viability in order to estimate the air quality.

Key words: Bio-indication, atmospheric pollution, pollen viability, SAMASAFIA, network control, Algeria

INTRODUCTION

The town of Annaba is one of the industrially polluted areas in Algeria, due to the existence of the industrial complexes, the most importants are: The EL Hadjar steel work and the phosphated manures complex (Asmidal). Moreover, it is well known for its dense road traffic and its overpopulation. That is what pushed the researchers to study this area air quality, among these studies (Semadi and Cormis, 1986; Semadi, 1989).

Several techniques were applied for the detection and the evolution of the air pollution: The physico-chemical techniques which constantly measure the concentrations of various pollutants (SAMASAFIA) and the biological techniques which use the plant or part of plant as bio-indicator. We quotes for example the lichens (Asta, 1980; Deruelle, 1983; Semadi, 1989) and pollen grains (Wolters and Martens, 1987; Tlili, 2000).

MATERIALS AND METHODS

Studied plants: We collected the pollen of *Malus communis* from a young tree located within the university of Annaba and the pollen of *Phoenix dactylifera* was stored in the refrigerator at (+5°C) in the laboratory of palynology since one year.

Zone of study: The zone of study located at the East of Algeria (Annaba). The sites are located in the 4 zones where are the stations of SAMASAFIA:

Zone (1): Health center at Annaba city,
Zone (2): Health center at El Bouni, distant of 6km from Annaba close to the Asmidal complex.
Zone (3): University of Sidi Amar, distant of 12 km from Annaba close to the EL Hadjar steel-work,
Zone (4): International Airport, of Annaba located at 10 km of the city.

Viability study: The viability of pollens was tested by two methods: by colouring with acetocarmine 45% and by *in vitro* germination in the gel medium of Bellani and Bell (1986) which is composition of: One Liter of distilled water, 100 g of saccharose, 0.2 g of the boric acid, 0.3 g of calcium nitrate, 10 G Agar with P^H = 6.5.

Exposure of pollen to air: The pollen of *Malus communis* and *Phoenix dactylifera* were puted in small canvas bags, and fixed on the trees (2 m height) during 24 h in 4 zones where the SAMASAFIA stations. Control pollens of *Malus communis* and *Phoenix dactylifera* were kept at the laboratory. After 24 h of exposure, we realized the viability tests.

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RESULTS AND DISCUSSION

Viability tests of *Malus communis* pollen after exposure: The Table 1, exposes the results. We note as well for this test of colouring as for *in vitro* germination a clear regression of viability compared to the control.

Indeed, the site El bouni seems the most polluted, followed by Annaba and sidi Amar, while the site of the airport showed the best results.

Viability tests of *Phoenix dactylifera* pollen after exposure: Through the Table 2, we noted that the colouring percentages and germination are clearly regressed notably at the site of El Bouni (55 and 29%). Through these results, we can say that the pollens grains are influenced by the air pollution of the exposure zones, that engender a reduction in pollens viability.

Bio-indication and data of SAMASAFIA: We compared the results of air analysis of SAMASAFIA and our results relating to the pollens viability after exposure to air Table 3, we note a certain coordination between results of germination test of *Malus communis* pollen and *Phoenix dactylifera* pollen and the pollutants values.

We tried to classify the studied sites according to the pollution degree from the least polluted towards most polluted:

Table 1: The comparison between the results of colouring, germination and the coefficient of correlation of *Malus communis* pollen

Viability Sites	% Colouring with acetocarmine	% Pollen germination	Coefficient of correlation
Control	98	87.06	0.88
Annaba	52	47.01	0.90
El Bouni	43	37.17	0.86
Sidi Amar	57	47.67	0.83
Airport	60	53.75	0.89

Table 2: The comparison between the results of colouring, germination and the correlation coefficient of *Phoenix dactylifera* pollen

Viability Sites	% Colouring with acetocarmine	% Pollen germination	Coefficient of correlation
Control	95	91.35	0.96
Annaba	65	51.00	0.78
El Bouni	55	29.00	0.52
Sidi Amar	70	62.00	0.88
Airport	80	75.35	0.94

Table 3: Comparison between the results of *in vitro* germination of the studied pollens after exposure and the SAMASAFIA data

	% Pollen germination		Pollutants	
Sites	*Malus communis*	*Phoenix dactylifera*	Carbon monoxide (μg m^{-3})	Dust (μg m^{-3})
Airport	53.75	75.35	00.00	25
Sidi Amar	47.67	62.00	0.35	63
Annaba	47.01	51.00	0.70	39
El Bouni	37.17	29.00	0.40	78

- The Airport sites.
- The Sidi Amar sites.
- The Annaba sites.
- The El Bouni sites.

In an experiment on Tabacco plant, pollen germination and pollen tube lengths were negatively affected by the application of heavy metals in increasing concentrations (Tuna *et al*., 2002).

The studies by Farkhondeh *et al*. (2003) showed the pollen collected from polluted area contained shrunken, destroyed, defective and fragile pollen and degradation of the surface.

All the concentrations (5, 10, 25, 50, 100, 200-200-1000, 1000-1000-5000 mg mL^{-1}) of herbicide 2, 4-Dichlorophenoxy acetic acid inhibited the germination of pollen as well as tube growth of *Paseolus aureus* (Salgare, 2004). In another study on five herb species (for *Vicia angustifolia*, *Vicia tetraperma*, *Pisum sativum*, *Medicago hispida* and *Plantago depressa*), were tested for responses in pollen germination and tube growth to cd exposure *in vitro*, pollen germination of all the species was inhibited at cd concentrations of 2.51 μg mL^{-1} and higher (Zhi-Ting and Yong-Hua, 2001). The inhibitory affects of air pollutants on pollen germination and tube growth may infuence plant reproduction (Wolters and Martens, 1987). The decline in enzyme activity and respiration also affect the pollen germination and pollen tube length negatively (Aydemir *et al*., 1988). Some other studies state that compounds with Hg among heavy metals prevent DNA replication andprotein synthesis, causing mitotic anomalies and that cu has similar effects, causing chromosome anomalies (De Flora *et al*., 1994).

In another study, on pollen tube growth and ultrastruture, the effects of Cd, Co, Cu, Fe, Hg, Mn, Zn and Al on the ultra-structure and pollen tube growth of *Lilium longiflorum* has also been studies and the higher rate of toxic effects was reported to be caused by Cd, Cu and Hg (Sawidis and Reiss, 1995).

CONCLUSION

Through the comparison of the SAMASAFIA data and the pollens germination rates after exposure, we noted a positive correlation between the two parameters: While the pollutants rates increased, the pollen germination rates decreased.

The bio-indication by pollen seems to be effective since the pollen contains an live cell very sensitive to all changes of environment parameters.

We noted according to SAMASAFIA data, that dust represent the most significant pollutant which exceed the threshold (50 μg m^{-3} 24 h^{-1}) of OMS (AIRFOBEP, 1999-2000) at sidi amar and notably at El Bouni.

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