

USE OF BIOACTIVE SUBSTANCES PRODUCED BY *CANNABIS SATIVA* L. FOR CLEANING BIOLOGICALLY CONTAMINATED MONUMENTS

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Abstract – Nature is a reservoir of bioactive substances called "secondary metabolites" that for many years has been considered cellular waste products or without a specific function. Secondary metabolites of *Cannabis sativa* L. were used against gram+ and gram- bacteria collected on historical bridge with the aim to realize an eco-sustainable bio-cleaning of the artifact. Tests *in vitro* on agar Petri dishes and calcareous stones contaminated were carried out.

The extracts obtained from flowers and leaves of the plant showed some effects only against gram+ bacteria. These results, confirmed by image analysis, can change the methods of preservation of our cultural heritage and can give rise to a new process of knowledge re-addressing the Cannabis cultivation.

Key Words – Cannabinoids, Bio-remediation, Calcareous stones

I. INTRODUCTION

The deterioration of stone in buildings and monuments through the action of biological organisms has been acknowledged since the mid-1960s; Hueck (1, 2) had used the term "Bio-deterioration" to mean «any undesirable change in the properties of a material caused by the vital activity of organisms», while Magaudda (3) defined the several stages of bio-deterioration (generic, acute and chronic) in relation to the damage observed and evaluated, and to the activity of bacteria present on the surface of the artistic objects.

Microbial action on stone begins with the initial adhesion of microorganisms to the surface and continues with the formation of a bio-film that can cause the loss of surface material, consistence drop, increasing of the porosity and other effects.

II. Natural bioactive compounds called secondary metabolites produced by plants, are showed to be able to clean, in a punctual way and avoiding chemicals, the contaminated surface of cultural heritage. Secondary metabolites produced

by inflorescence and leaves of *Cannabis sativa* L. were used to pursue this objective and the extracts were tested against many autochthonous bacteria collected on S. Vito bridge, an historical bridge located in suburban area of Potenza city (Basilicata Region).

III. MATERIALS AND METHODS

Inflorescences and leaves of *C. sativa* L., representative samples of the hemp-type accession Eletta Campana, were used for the experiments.

The steps followed were:

- extraction and sample preparation for biological assays using sequential and increasing polarity extraction, which allowed to avoid the limited range of metabolites extracted with a single extraction method (Heyman and Meyer 2012) (4).
- extracts characterization by using an HPLC system with DAD coupled to a hybrid linear quadrupole ion trap (LTQ) - Fourier transform ion cyclotron resonance (FTICR) mass spectrometer (Thermo Fisher Scientific, Bremen, Germany), equipped with a 20 W continuous carbon dioxide CO₂-laser (Synrad, Mukilteo, WA, USA)
- extracts tests (on agar plates and on calcareous stones contaminated) against gram+ and gram- bacteria collected on S. Vito bridge (Fig 1).



Fig. 1. S.Vito bridge

IV. RESULTS AND DISCUSSION

Figure 2 and 3 show respectively the bacterial activities on the surface of calcareous stones and the bio-deteriogen microorganisms found and identified on the bridge

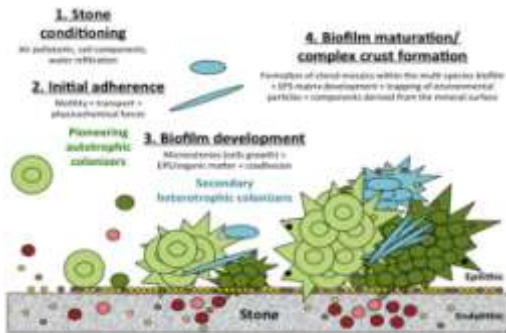


Fig. 2. Bacterial activities

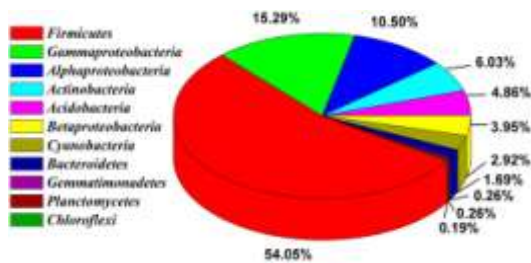


Fig. 3. Biodeteriogen microorganisms

Experiments in vitro (in agar Petri dishes and on calcareous stones) showed a good activity of flowers and leaves extracts only against gram+ bacteria. The same assays were carried out using cannabinoids standard, alone and in mixture, with the aim to simulate the extracts action. Results obtained were positive but the efficacy was lower than the natural extracts, evidencing the synergic action of minor components content in the vegetal extract. On calcareous stones Scanning electron analysis confirmed these results (Figure 4)

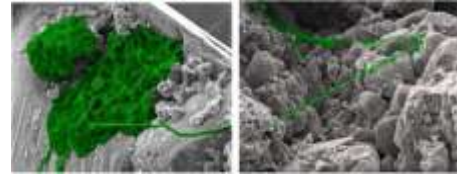


Fig. 4. Calcareous stone before(a) and after treatment (b)

V. CONCLUSION

In conclusion, the use of natural substances for environmentally friendly cleaning of monuments or buildings belonging to the historical heritage has recently been taken into consideration and it is proving an interesting success for the reproducibility of results and for the constant and punctual maintenance of active properties. The revaluation of many plants, including *C. sativa*, demonized and considered exclusively as harm to the human community, can allow to start a virtuous process of knowledge growth and the re-addressing of cultivation. In order to overcome the actual controversies it can be suggested, in addition, the creation of interdisciplinary educational and research networks

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