Compost from plant and animal residues of a zoo park improves the fertility of soils and increases the growth and production of lettuce

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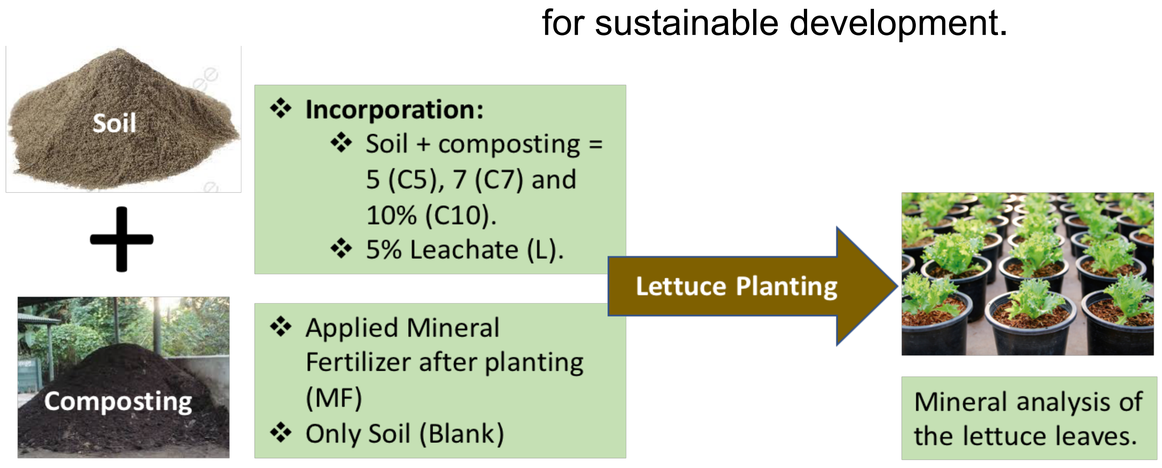
INTRODUCTION

Figure 1: Production of compost from SPZP and its application in the soil for production of lettuce.

Composting is a biological decomposition and stabilization of organic substrates that can be applied to the soil for fertilization (Figure 1) [1]. The São Paulo Zoo Park (SPZP) produces compost using all organic waste from the park and applies it on their own farm crops to be used for the animals feeding [2]. The aim of this study was to evaluate the potential of this composting in providing nutrients to the foods (Figure 2). This recycling process applied in the dependences of the Zoo, knowing as CIRCULAR ECONOMY, serves as a tool for sustainable development.



- **Incorporation:**
  - Soil + composting = 5 (C5), 7 (C7) and 10% (C10).
  - 5% Leachate (L).
- Applied Mineral Fertilizer after planting (MF)
- Only Soil (Blank)

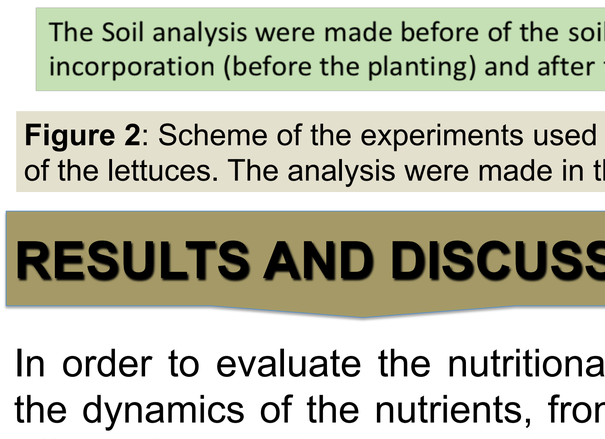
Mineral analysis of the lettuce leaves.

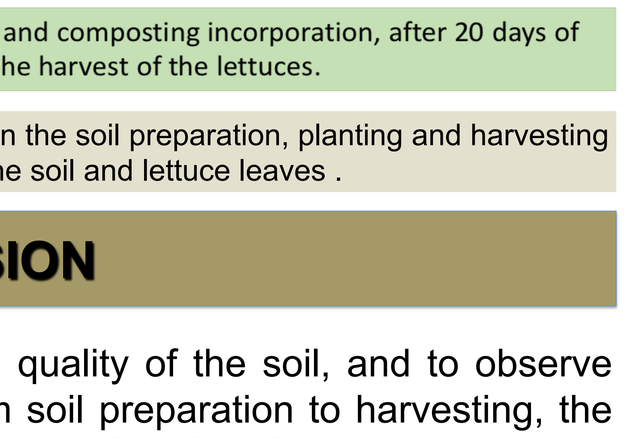
The Soil analysis were made before of the soil and composting incorporation, after 20 days of incorporation (before the planting) and after the harvest of the lettuces.

Figure 2: Scheme of the experiments used in the soil preparation, planting and harvesting of the lettuces. The analysis were made in the soil and lettuce leaves .

RESULTS AND DISCUSSION

In order to evaluate the nutritional quality of the soil, and to observe the dynamics of the nutrients, from soil preparation to harvesting, the effect of the soil treatments (Blank, L, C5, C7, C10, and MF) were evaluated before planting (Blank), at the time of seedling (L, C5 – C10), and after harvesting the plants (all six treatments), Figure 3 (A,B and C). The soil before planting (Blank) contained 22 g dm^{-3} of organic matter, pH 3.0, and 40 $mmol_c$ dm^{-3} CEC; when organic material was added to the soil producing the treatments L, C5, C7, and C10, pH and CEC increased significantly improving the soil nutritional quality, (Figure 4A and 4B).





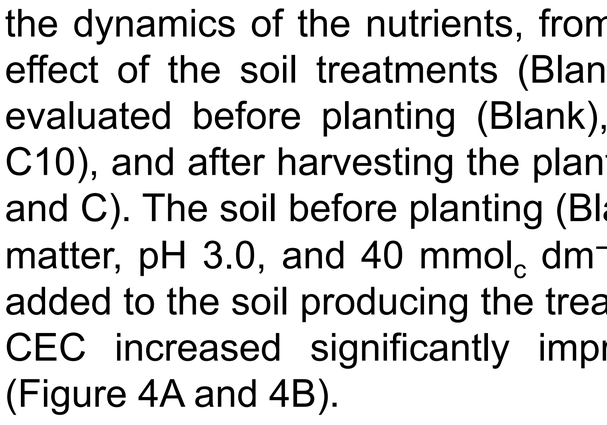


Figure 3: Development of lettuce growth under different soil conditions:
(1) 5% compost – C5; (2) 7% compost – C7;
(3) 10% compost – C10; (4) leachate – L;
(5) blank soil (blank); (6) mineral fert. – MF.
The photographs were taken at three different stages of the plant growth:
(A) planting;
(B) 15 days after planting;
(C) 40 days after planting (harvest).

References

[1] Haug, R.T.; Haug, H.T. Practical Handbook of Compost Engineering. Lewis Publishers, B. Raton, **1993**.

[2] Lima-Junior, J.D.; Viana-Niero, C.; Conde, Oliveira, et al. Characterization of mycobacteria and mycobacteriophages isolated from compost at the São Paulo Zoo Park Foundation in Brazil and creation of the new mycobacteriophage Cluster U. BMC Microbiol.16 (1), 111-125, **2016**.

Chemometrics Analysis

Soil Analysis

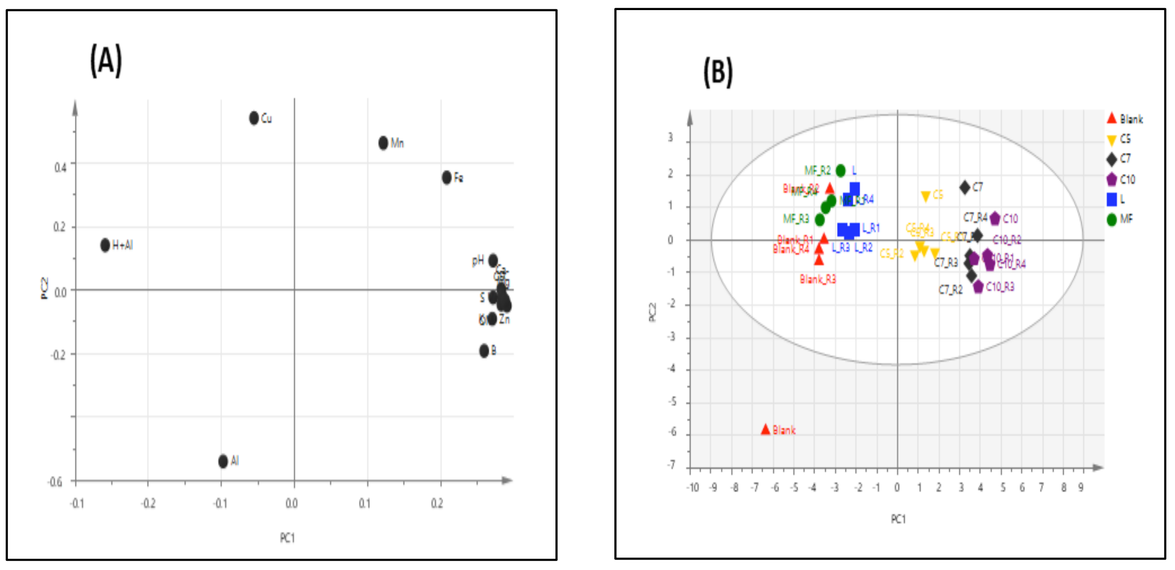


Figure 4: PCA of the chemical composition of the soil at different treatments: original soil (Blank) and soil modified with mineral fertilizer (MF), leachate (L), and composting at three concentration levels (C5, C7, and C10). A) Loadings plot showing the mineral profile of the samples; B) Scores plot grouping the samples according to their mineral characteristics.

Lettuce Analysis

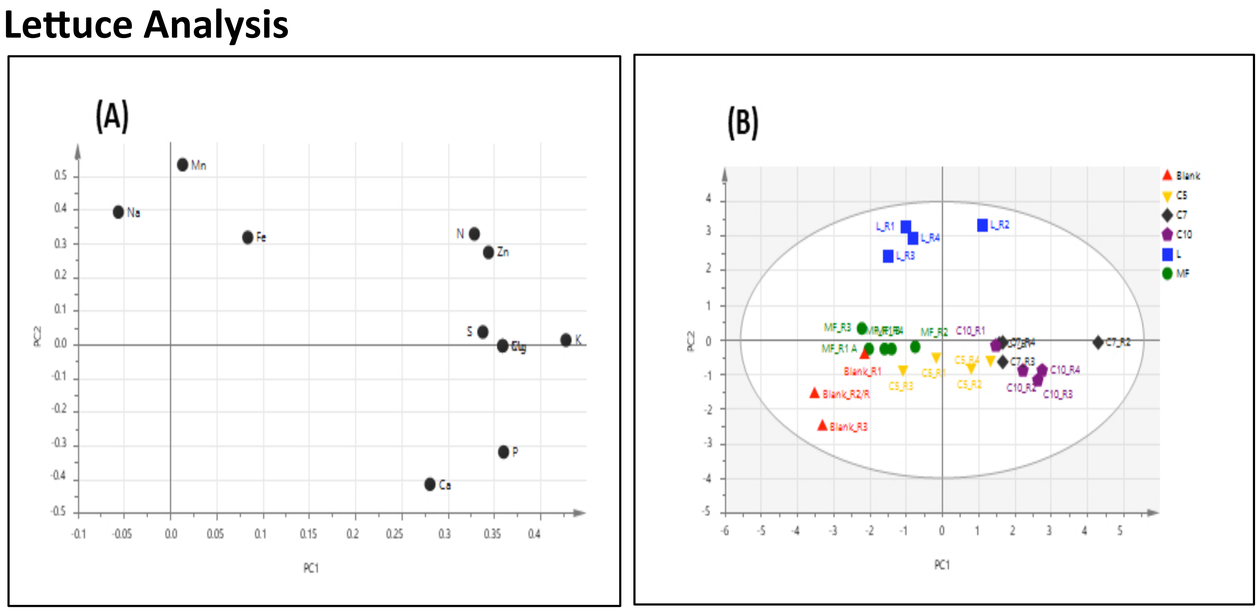


Figure 5: PCA of nutrients levels in lettuce leaves under different planting conditions. A) Loadings plot variables; B) Scores plot, grouping the soils treatments according to their mineral characteristics.

In the loadings graph (Figure 5A), lettuce seedlings treated with leachate (L replicates) produced leaves that are mostly found in the upper half of the PCA score graph (Figure 5B), which were characterized by the levels of Mn, Na, and Fe. In the leaves of lettuce cultivated with leachate, the average level of Fe was 422 mg kg^{-1}. Lettuce plants grown in soil treated with compost and MF presented similar Fe levels, which varied from 322 to 422 mg kg^{-1}. On the other hand, plants grown without any fertilization showed low levels of this nutrient. The fertility analysis showed an improvement in the quality of the composted soil due to the presence of nutrients such as Mg and Fe, and the increase of pH. The elevation of pH was responsible for providing other nutrients to the plants, that although present in the soil, they were not bioavailable.

CONCLUSIONS

- The production of compost at the SPZP saves over US$ 50,000/year on the costs of residues disposal in landfills as well as in expenses in tons of fertilizers/year used in the zoo garden and at the farm, where most of the animals feed is produced.
- Besides this economic value, it was possible to demonstrate that a poor soil can be corrected to produce high-quality crops by adding small amounts of compost (5-10%) in the soil to produce high-quality lettuces, which was not possible to achieve even when using mineral fertilization over the soil.
- This management practice has been contributing to the CIRCULAR ECONOMY and consequently to the development of sustainability in the Zoo, besides providing to the society sustainable forms of economy development without degrading the environment and generating resources.

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