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The estuary of the Botafogo river, located in the north coast of the State of Pernambuco, Brazil, is a site of fishing activities and it contains the largest hydrographic basin fully inserted in the region. Previous studies have shown that there is contamination in the mangrove areas by heavy metals. However, investigations about the dynamic and potential availability of metals are necessary to base analysis of risk to the environment and human beings. The objectives of this study were to determine the total contents of chromium (Cr), copper (Cu), lead (Pb) and zinc (Zn) and to evaluate their availability to the environment. Based on previous data, three areas under *Laguncularia racemosa* vegetation in the Botafogo Estuary and one area without contamination were selected. In each area, there were four collected profiles of soil (0-50 cm). Analysis for organic matter (MOS), particular size distribution and total digestion (HNO<sub>3</sub>, HF, HClO<sub>4</sub> and HCl) were performed in samples of 0-4, 4-8, 8-12, 12-16, 16-20, 20-30, 30-40 and 40-50 cm. The potential of availability of metals in the environment was evaluated by sequential extraction of the soil from the area of high contamination. The average levels of Cr, Cu, Pb and Zn (0-50 cm) were found to be higher than the reference area and it was not found to be decreasing with the depth of the soil. The average variation within depth (0-50 cm) was 31%, 60%, 41% and 39% for Cr, Cu, Pb and Zn. Elevated variations of metals can be attributed to the variations in texture (32%) and MOS (32%) observed among the profiles, especially in the third area where the layer 40-50 cm is predominantly sandy (sand: 668 g kg<sup>-1</sup>) and confirmed with the positive correlations between MOS, clay and metals ( $p < 0.05$ ). From the sequential extraction (soil of second area), it was verified that Cr, Cu, Pb and Zn were mainly associated with the residual fraction (metals associated with silicates and organic matter). However, 27% of total Cu was associated with the pyrite fraction. In anoxic conditions, this fraction is stable. About 18% and 32% of Pb and Zn were associated with amorphous iron oxide and carbonate fractions. The Pb-carbonate association is stable near neutrality as found in the analyzed soil (pH: 6.57). The contents of Cr, Cu, Pb and Zn were found above the reference area, however, they are associated with stable fractions of soil, indicating the low potential of availability of these elements to the environment.

**Keywords:** Contamination; heavy metal; mangrove.

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**(6439 - 2881) Availability of heavy metals and other elements in soils under influence of the Itataia uranium-phosphate deposit in Brazil**

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Heavy metals and other potentially toxic elements in soils might pose risks to humans or ecosystems even in small concentrations. Although the knowledge of the total content of heavy metals in soil is important, there is still concern related to the available forms of these elements, which are able to be absorbed by the living beings and thus enter the trophic chain. The objective of this work was to evaluate the levels of heavy metals and other elements available in soils under influence of the uranium-phosphate deposit of Itataia, considered the largest uranium reservoir in South America. Simple deformed soil samples were collected at 53 points in the 0-20 cm layer, and the available levels of Al, B, Cd, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Ti, Zn e Zr were extracted (Mehlich 1) and determined using inductively coupled plasma-atomic emission spectrometry (ICP-AES 6300 DUO). Were found available levels of Cd, Hg, Ni, and Pb in all samples, and no values of Cu, Ti or Zr were detected. Available B and Co was detected in more than 80% of samples, and for Mo, Al, Zn, Mn and Fe in less than 60% of the samples. The results showed many extreme values and asymmetric distribution for most of the data and no normality

was observed after the Kolmogorov-Smirnov test. Pb was the element that presented the highest levels in the area, with a median of 16.35  $\mu\text{g kg}^{-1}$ . Al although detected in only 40% of samples, was the element that showed the highest extreme value, 431.92  $\mu\text{g kg}^{-1}$ . The available heavy metal contents showed the following decreasing order: Pb > Ni > B > Hg > Co > Mo > Cd > Al > Zn > Mn > Fe > Cu, Ti, Zr. The available content was compared with the total content of these elements in the soil. In this way, Lead was the element that presented the largest amount available in relation to its total content (approximately 25%), then Cd > B > Mo > Ni > Zn > Co > Mn > Al > Fe. The low availability of the metals in the area can be due to pH (7.43) and soil organic carbon (26.56 g kg<sup>-1</sup>). The present study indicated that due to the low levels of heavy metals and other elements of soils from the Itataia deposit, there is no risks of pollution to the local environment.

**Keywords:** Soil pollution. Heavy metals availability. Mining.

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**(5879 - 831) Biochar from biosolids microwaved-pyrolysis: Characteristics and potential for use as growing media amendment**

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Biochar, produced from biosolids using microwave pyrolysis technology, is energetically a more efficient alternative to that produced with conventional convective heating. However the potential of microwave generated biochar as a growing media amendment has not been sufficiently explored. Here we produced biochar from biosolids using microwave energy. The pyrolysis experiments were conducted in two stages, initially using a custom built single mode chamber to explore the energetics and product distribution of the pyrolysis process at different temperatures and secondly in a 1 m<sup>3</sup> 6 kW multi-mode chamber, to explore potential scale-up of the process. The second phase of the pyrolysis experiments was focused on biochar generation for use in the remainder of this research. Microwave pyrolyzed biochar (MB) was characterised for its chemical and physical properties. Then, we conducted a greenhouse experiment, where we compared the ability of four growing media mixes that combined pine bark with (i) sphagnum peat and fertilizers; (ii) 20% MB and fertilizers; (iii) 60% MB and fertilizers; and (iv) 60% MB and no fertilizers, to promote plant growth and nutrient uptake and to minimise leaching losses. MB had high mesoporosity (average pore width of 4.46 nm), moderate surface area (75 m<sup>2</sup> g<sup>-1</sup>), elevated nutrient content and low heavy metal concentrations as compared to other biosolids biochars reported in literatures. Substitution of peat with 60% MB on volume basis reduced leaching loss of nitrate and phosphate from the media but increased leaching loss of ammonium. Addition of MB in conjunction with fertilizer increased plant growth and plant nitrogen and phosphorus use efficiency. Our study has shown microwave pyrolysis as a promising technology for pyrolyzing biosolids and also has demonstrated the synergistic interaction of MB and fertilizer which results in greater plant growth and nutrient uptake and use efficiency.

**Keywords:** Microwave pyrolysis Characterization Biosolids Energy Plant growth

**Financial support:**

**(9218 - 2053) Biogas and biofertilizer production from dairy cattle manure under organic and conventional production systems in Seropédica, Rio de Janeiro (Brazil)**

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The production of milk in Brazil stands out as one of the main agricultural activities. The quality and efficiency standards in the milk production have been required in recent years with the objective of intensify even more the production system. As a consequence, there is an increase in the amount of residues generated during the milk productive chain which can lead to a contamination of the soil, the water and the air. The goal of this study was to evaluate the production of biogas potential and biofertilizer resulting from the anaerobic biodigestion of dairy cattle manure under organic and conventional production system. The experiment was built eight prototypes of benchtop biodigesters, being the supply system discontinuous. The treatments evaluated were: a) CMOS - cattle manure under organic production system, from Agroecological km 47 Farm; b) CMCS - cattle manure under a conventional production system, from the dairy cattle sector of the Agricultural Research Company of the State of Rio de Janeiro. Analyzes were performed based on the methodology described by APHA (2005), United States Environmental Protection Agency and CONAMA 357/06. After the anaerobic biodigestion process it was observed that the concentrations of thermotolerant coliforms were below than the limit established by law. The cumulative biogas production was 6.18 L and 11.15 L, when using the CMOS and CMCS, respectively. DBSO and DBSC biofertilizers presented a carbon content ( $392.4$  and  $411.9 \text{ g kg}^{-1}$ ) to be considered an organic fertilizer. Magnesium, potassium and iron contents were higher in DBSO biofertilizer but calcium, manganese, copper, zinc and barium contents were higher in DBSC. DBSC biofertilizer had cadmium content above that allowed by organic fertilizers law. The organic and conventional management production of milk influenced the production of biogas. CMCS presented a higher accumulated biogas production with higher energy potential when compared to CMOS. The management adopted can have influenced the production of biogas through the feed supplied to the animal, demonstrating that in the conventional management a feed based on concentrate, roughage and commercial feed contributed in a more significant way for biogas production in relation to the one where the animals fed only from a roughage-based feed produced on organic property. On the other hand, dairy cattle manure from CMOS showed greater potential to be used as organic fertilizer when compared to the CMCS.

**Keywords:** Soil pollution, anaerobic biodigestion, biodigester, agricultural waste.

**Financial support:** Federal Rural University of Rio de Janeiro (UFRRJ) and Paraíba do Sul River Basin Agency (AGEVAP).

#### (3037 - 2241) Building of probe-type passive sampler to study the contents of heavy metals in the aqueous phase

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“Dissolved” concentrations of contaminants in the soil provide a more relevant description for risk assessment than the total concentrations. But also, the perturbation of the soil during sampling process must be highly minimized in order to obtain the best results regarding the real field conditions. In this context, passive sampling methods for estimating “Dissolved” concentrations offer the potential for cost-efficient and accurate in situ characterization of pollutants in the soils, exactly, the aqueous phase. In this work, the building of probe-type passive sampler to study the contents of heavy metals in the aqueous phase of soils was developed. For that, clay (montmorillonite) was immobilized on the poly(vinyl chloride) surface by thermal methods. Next, surface functionalization or chemical activation was performed by chemical insertion of vinyl units easily polymerizable by free-radical polymerization. Later, poly(sodium vinyl estearate) chains were inserted using ammonium persulphate as radical initiator and deionised water as reaction phase. Different chain lengths were promoted by the modification of initiator amounts. In all cases, materials were characterized by infrared, scanning electron

microscopy, thermogravimetric analysis and contact angle measurements. Retention properties were evaluated as a function of pH and ionic strength using  $\text{Pb}^{+2}$ ,  $\text{Hg}^{+2}$  and  $\text{As}^{+2}$  as target ions. Aqueous extract of soil samples were used to identify the effect of composition on retention properties. Results demonstrate that probe-type passive samplers can be made by described methodology; in addition, retention of ions was identified to decrease as pH is decreased and affected by metal speciation as pH is increased.

**Keywords:** humic acid, fulvic acid, hydrogen bonds

**Financial support:**

#### (6371 - 1158) Cadmium buffer capacity in Chilean soils with different reactivity

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The cadmium availability for plants is related with their mobility, transport and distribution of the metal in the soil. This availability is determined by the soil buffer capacity, which depends on their reactivity. Cd dynamics is described by sorption and desorption processes which depend of the chemical form of the metal and the soil intrinsic characteristics. This study aimed to assess the variation of the Cd buffer capacity (CP) among different agricultural soils. Three types of soils (Ultisol, Andisol and Alfisol) which present differences in their reactivity were characterized. Each soil was enriched with 5 different amounts of CdCl ( $0, 10, 50, 80, 120 \text{ mg kg}^{-1}$  Cd; estimated in function the Cd input to the soil related to the use of fertilizers and agricultural residues) and incubated during 17 days (at  $25^\circ\text{C}$  and 50% humidity). The available Cd was determined at days 1, 9 and 17 during the incubation. The available Cd was extracted by EDTA (0.05 M), pH 7.0, at soil:solution ratio of 1: 2,  $\text{MgCl}_2$  (1M), pH 7.0, 1: 2; and,  $\text{CaCl}_2$  (0.01. M) 1: 2. Differences in the Cd buffer capacity of the studied soils were observed, with Andisol (CP = 0.4) < Alfisol (CP = 7.2) < Ultisol (CP = 50). These results suggest that the soil reactivity is an important factor in the fraction of Cd available for plants. However, the amount of Cd extracted was different between the three methods evaluated. However there are certain equivalences between them, e.g.,  $\text{CaCl}_2$  extracts 50% less of Cd comparing with EDTA and  $\text{MgCl}_2$ , where the two last extractantes showed differences of 2-10% in the available Cd extracted from the three soils. There was no significant effect of the times considered in this study on Cd buffer capacity evaluated.

**Keywords:** Cadmium buffer capacity, soil reactivity, sorption-desorption, Soils of Chile

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#### (5559 - 2807) Cerium content in roots of arabica coffee cultivated in soil amended with phosphogypsum

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Phosphogypsum is used in coffee plantations to favor the deepening of the plants roots. However, in addition to the nutrients, the phosphogypsum present low amounts of rare earth elements (REE), like cerium (Ce), which is generally found in higher concentration. There are scientific evidences of diseases pulmonary, neurological, and even cancer in animals due to chronic exposure to high