
Effect of a passivator synthesized by wastes of iron tailings and biomass on the leachability of Cd, Pb and safe of pakchoi (*Brassica chinensis* L.) in contaminated soil.

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Elucidate the migration and transformation of heavy metals through the Bio-concentration factor (**BCF**) and translocation factor (**TF**). These were calculated as following; Bio-concentration factor (BCF) as: heavy metal concentration in crops issue (mg/kg)/ heavy metal concentration in soil (mg/kg). Translocation factor (TF) as: heavy metal concentration in shoots (mg/kg)/ heavy metal concentration in roots (mg/kg).

$$BCF = \frac{C_{Belowground}}{C_{Soil}} \quad (1)$$

$$TF = \frac{C_{Aboveground}}{C_{Belowground}} \quad (2)$$

Where, $C_{Belowground}$ is the heavy metal concentration in crops issue of root (mg/kg), C_{Soil} is the heavy metal concentration in soil; $C_{aboveground}$ is the heavy metal concentration in crops issue of shoot (mg/kg).

The estimated daily intake of vegetables (EDI, $\mu\text{g/kg}\cdot\text{d}$) of local residents was used to assess the potential risks to the human body. The formula is as follows:

$$EDI = \frac{C_{Aboveground} \times CL}{BW} \quad (3)$$

The target hazard quotient method (THQ, US Environmental Protection Agency) is used for health risk assessment, and the ratio of the exposure dose of heavy metal pollution to the reference dose of Chinese cabbage is used to characterize the non-carcinogenic risk level [1].

The formula is as follows (2):

$$THQ = \frac{C_{crop} \times CL \times EF \times ED}{BW \times AT \times RFD} \quad (4)$$

Where: C_{crop} is the content of the edible part of the plant, mg/kg; CI is the daily input of vegetables per person, kg/person·d; EF is the daily exposure frequency, 365 d/a; ED is the average exposure duration, a; AT is the average exposure time $365 \times ED$, d; BW is the reference

body mass of the human body, kg; RfD is the reference dose of toxic heavy metal exposure, mg/kg-d. The oral dose of the corresponding pollutants in this study refers to the EPA 2010 environmental standard [3], The oral doses of Pb and Cd were Pb 0.0035 mg/kg-d and Cd 0.001 mg/kg-d, respectively. With reference to previous studies, the reference body weight of adults in Shangba Village is 60.5 kg, the reference body weight of children is 29.3 kg [2], and the duration of exposure for adults and children is 70 a and 12 a, respectively.

References

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- [3] USEPA. Risk-based concentration table[DB/OL]. [2019-12-10]. [http : //www. epa. gov/reg3hwmd/risk/human/index. htm](http://www.epa.gov/reg3hwmd/risk/human/index.htm).

Table S1. The composition (%) of tailings by XRF and the heavy metal in tailings and MR.

| Tailiings composition | (%) | Heavy metal (mg/kg) | Tailings | MR |
|--------------------------------|-------|---------------------|----------|--------|
| Fe ₂ O ₃ | 70.25 | Cu | 2350.31 | 300.5 |
| SiO ₂ | 15.85 | Pb | 1443.63 | 89.61 |
| Al ₂ O ₃ | 7.85 | Zn | 1476.66 | 216.5 |
| SO ₃ | 3.67 | Cd | 5.19 | 0.49 |
| K ₂ O | 0.57 | Fe | 460174 | 381800 |
| Other | 1.81 | | | |

Table S2. Leaching toxicity of the T-BC under different biomass and urea rate.

| Passivator sample | Zn (mg/L) | Cu (mg/L) | Cd (mg/L) | Pb (mg/L) |
|-------------------|-----------|-----------|-----------|-----------|
| MB | - | - | - | - |
| T-BC1 | - | - | - | - |
| T-BC2 | - | - | - | - |
| T-BC3 | - | 0.01 | - | - |
| T-BC4 | 0.005 | 0.05 | - | - |
| T-BC5 | 0.05 | 0.12 | - | 0.003 |
| T-BC6 | 0.09 | 2.65 | - | 0.011 |
| T-BC7 | 0.18 | 4.75 | - | 0.025 |
| MR | 5.78 | 45.00 | - | 1.78 |
| Iron tailings | 15.37 | 47.37 | - | 13.78 |

| Standard | 100 | 100 | 1 | 5 |
|--|-----|-----|---|---|
| “-” denotes not detected; Standard mean Identification standards for hazardous wasters-Identification for extraction toxicity (GB 5085.3-2007) | | | | |

Table S3. Some physical and chemical properties of the different treatments soil.

| Treatement | pH | CEC | SOC | DOC | A-P | A-Si | A-K | A-Mg | A-Ca |
|------------|-----------|------------|-----------|-------------|------------|-------------|-------------|------------|-------------|
| BC0 | 4.57±0.15 | 9.72±0.08 | 1.89±0.03 | 115.76±1.84 | 8.79±0.05 | 75.01±2.52 | 76.29±2.30 | 46.51±0.86 | 159.38±2.99 |
| BC0.5 | 4.96±0.02 | 9.88±0.06 | 1.90±0.05 | 103.74±2.02 | 11.78±0.18 | 107.23±2.54 | 111.34±5.96 | 65.61±1.41 | 213.10±4.60 |
| BC1 | 5.04±0.01 | 9.95±0.05 | 1.93±0.07 | 177.5±2.30 | 14.37±1.04 | 133.26±6.79 | 185.22±3.97 | 76.59±1.2 | 338.91±4.28 |
| BC2 | 5.21±0.01 | 9.98±0.11 | 1.95±0.06 | 195.8±2.84 | 16.56±1.06 | 144.92±3.48 | 140.98±9.82 | 64.81±2.47 | 283.03±7.69 |
| MB | 5.37±0.04 | 10.03±0.21 | 1.96±0.08 | 230.88±3.78 | 14.45±0.03 | 131.55±4.25 | 147.81±7.23 | 86.05±4.22 | 288.12±8.18 |

MB denotes MB added doses of 20 g/pot; DOC mean dissolved organic carbon; A-P mean Available P; A-Si mean Available Si; A-K mean Available K; A-Mg mean Available Mg; A-Ca mean Available Ca.

Table S4. The yield and harvest index of pak choi for different treatments.

| Treatment | Yield (g/pot) | Root (g/plant, Dry weight) | Shoot (g/plant, Dry weight) | Harvest index |
|-----------|------------------|-------------------------------|--------------------------------|------------------|
| BC0 | 21.06±0.43 d | 0.39±0.02 d | 2.55±0.12 d | 0.87±0.02 c |
| BC0.5 | 24.9±1.12 c | 0.43±0.05 c | 3.03±0.21 c | 0.88±0.01 b |
| BC1 | 28.36±0.48 b | 0.48±0.03 a | 3.46±0.14 b | 0.88±0.01 b |
| BC2 | 34.84±2.03 a | 0.42±0.05 c | 4.27±0.31 a | 0.91±0.02 a |
| MB | 34.32±1.97 a | 0.46±0.04 b | 4.20±0.09 a | 0.90±0.02 a |

BC0, BC0.5, BC1 and BC2 mean as soil applied with T-BC of four rate (0, 0.5, 1 and 2% (w/w)); MB mean as soil applied with biochar (2% (w/w)) from mango leaves.

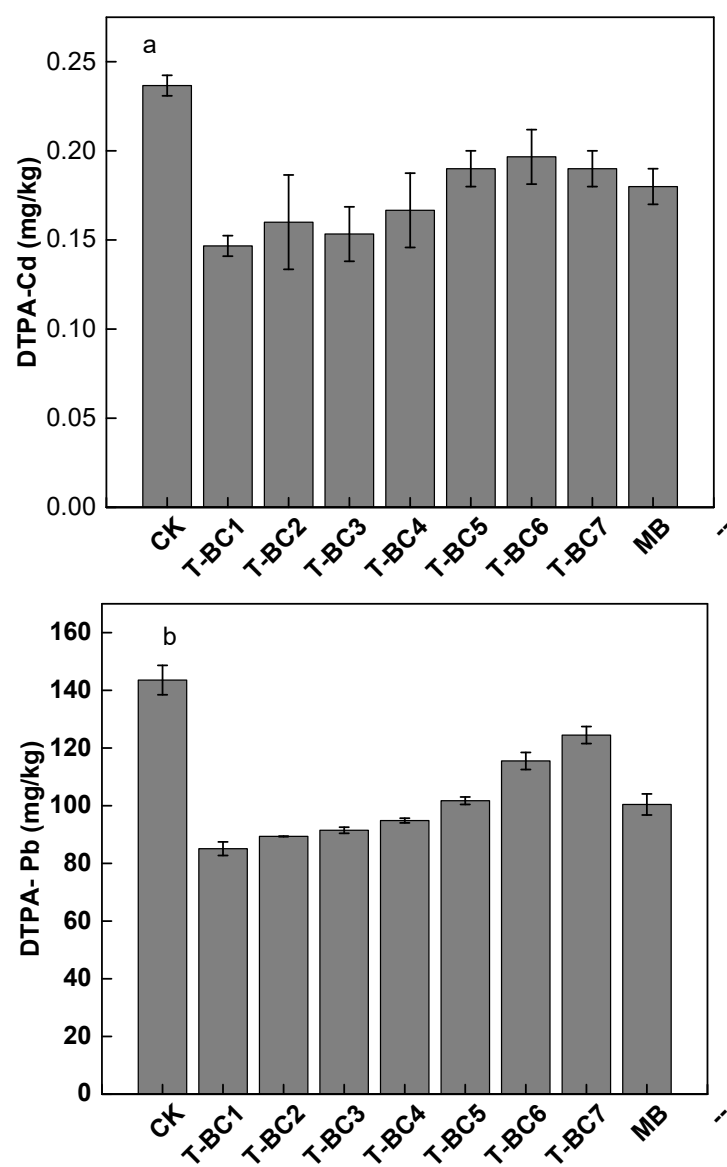


Figure S1. The effect of various T-BC on concentrations (mg /kg) of the DTPA-extractable (Cd),(Pb) in soil.

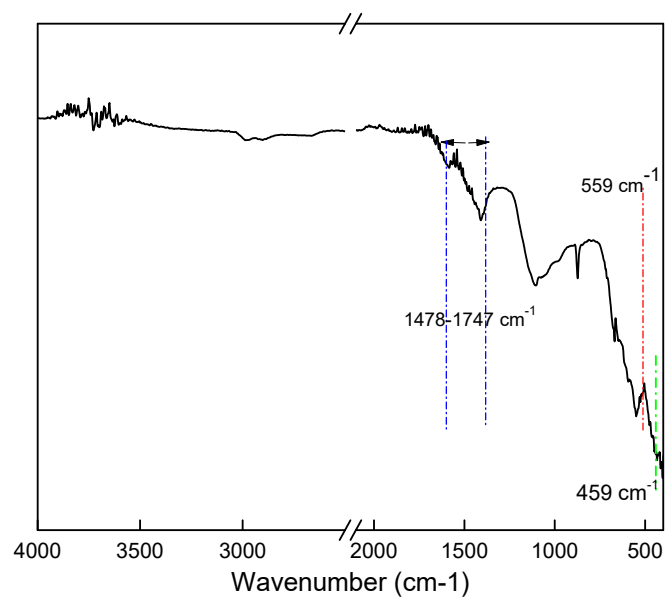


Figure S2. The FTIR spectra of T-BC4.