# RESULTS

## Section : I

## Heavy metals concentration in initial feed mixture and vermicompost of different animal dungs with municipal solid wastes and kitchen wastes

The data were displayed in Tables 2-13 and illustrated in Figures 1-12. The concentration of different heavy metals, namely, cobalt (Co), chromium (Cr), lead (Pb), nickel (Ni), cadmium (Cd) and arsenic (As) were determined in vermibeds prepared from different combinations of animal (buffalo, cow, goat, horse and sheep) dungs with municipal solid wastes (MSW) and kitchen waste (KW) in ratio of 1:1, 1:2 and 1:3 in initial feed mixture of vermibeds and in vermicomposts. It implies that the earthworm, *Eisenia foetida* is effective in lowering down the heavy metals in different animal dungs, MSW and KW tested during vermicomposting (60 days).

### (1) Cobalt (Co)

Data displayed in (Table 2) and illustrated in (Figure 1) demonstrated that there was a significant ($P<0.05$) change in the

concentration of cobalt in the vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. There was a significant decrease in the concentration of Co in vermicomposts of all combinations of animal dungs with municipal solid wastes. Maximum decrease in the concentration of Co in the vermicomposts obtained from the combination of buffalo dung with municipal solid wastes in ratio of 1:1 was observed (100%, from 0.017±0.007 mg/kg to below detection limit (BDL)) followed by goat dung with municipal solid wastes in the ratio of (1:1) (90.79%, 0.076±0.004 to 0.007±0.004 mg/kg), horse dung with municipal solid wastes in the ratio of (1:3) (86.08%, 0.079±0.006 to 0.011±0.005 mg/kg), cow dung with municipal solid wastes in the ratio of (1:3) (84.91%, 0.053±0.008 to 0.008±0.002 mg/kg) and sheep dung with municipal solid wastes in the ratio of (1:3) (80.33%, 0.061±0.005 to 0.012±0.005 mg/kg). In other combinations of animal dungs and MSW, the percentage of decrease in the Co level in the vermicomposts ranged between 10.0% (in MSW) to 79.31% (in buffalo dung).

Similarly, there was a significant decrease in the concentration of Co in vermicomposts of all combinations of animal dungs with kitchen wastes (KW) (Table 3). Maximum decrease in the concentration of Co in the vermicomposts obtained from the combination of buffalo dung with kitchen wastes in ratio (1:3) was observed (87.59%, from 0.290 ± 0.006 to 0.036 ± 0.003 mg/kg) followed by sheep dung with kitchen wastes in

the ratio of (1:2) (86.33%, 0.256 ± 0.007 to 0.035 ± 0.002 mg/kg), goat dung with kitchen wastes ratio (1:3) of (84.21%, 0.152 ± 0.003 to 0.024 ± 0.005 mg/kg). In other combinations of animal dungs and kitchen wastes, the percentage of decrease in the Co level in the vermicomposts ranged between 51.35% (in Goat dung with KW) to 79.72% (in Sheep dung mixed with KW). It implies that the earthworm, *Eisenia foetida* is effective in lowering down the Co in different animal dungs and KW tested during the vermicomposting more than 50% in all treatments (Figure 2).

## (2) Chromium (Cr)

Data displayed in (Table 4) and illustrated in (Figure 3) demonstrated that the concentration of Cr decreased more than 80% in the vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. Maximum decrease in the concentration of Cr in the vermicomposts obtained from the combination of cow dung (91.27%, from 0.848 ± 0.003 to 0.074 ± 0.003 mg/kg) was observed followed by cow dung mixed with municipal solid wastes in the ratio of (1:3) (89.11%, 0.799 ± 0.003 to 0.087 ± 0.004 mg/kg), goat dung with municipal solid wastes in the ratio of (1:1) (89.09%, 0.843 ± 0.007 to 0.092 ± 0.003 mg/kg), and goat dung with municipal solid wastes in the ratio of (1:3) (88.86%, 0.844 ± 0.004 to 0.094 ± 0.004 mg/kg).

There was a significant decrease in the concentration of Cr in vermicomposts of all combinations of animal dungs with KW. The concentration of Cr was maximum decrease in the vermicomposts obtained from the combination of buffalo dung with kitchen wastes in ratio of (1:3) was observed (92.11%, from 0.786 ± 0.006 to 0.062 ± 0.003 mg/kg) followed by cow dung with kitchen wastes in the ratio of (1:1) (89.43%, 0.766 ± 0.004 to 0.081 ± 0.004 mg/kg), goat dung with kitchen wastes ratio (1:3) (87.34%, 0.885 ± 0.003 to 0.112 ± 0.004 mg/kg), sheep dung with kitchen wastes in the ratio of (1:3) (86.75%, 0.770 ± 0.006 to 0.102 ± 0.006 mg/kg), horse dung with kitchen wastes ratio (1:1) (86.53%, 0.757 ± 0.004 to 0.102 ± 0.007 mg/kg) (Table 5), In other combinations of animal dungs and kitchen wastes, the percentage of decrease in the Cr level in the vermicomposts ranged between 76.91% (in goat dung) to 86.29% (in horse dung) (Table 5, Figure 4).

## (3) Lead (Pb)

Data displayed in (Table 6) and illustrated in (Figure 5) demonstrated that the concentration of Pb decreased more than 96% in the vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. The maximum decrease in the concentration of Pb in the vermicomposts obtained from the combination of buffalo dung with municipal solid waste in the ratio of (1:1) was observed (96.73%, from 1.773 ± 0.008 to 0.058 ± 0.003

mg/kg) followed by sheep dung with municipal solid wastes in the ratio of (1:3) (95.64 %, 0.757 ± 0.007 to 0.033 ± 0.005 mg/kg), goat dung with municipal solid wastes in the ratio of (1:2) (93.49%, 1.674 ± 0.004 to 0.109 ± 0.003 mg/kg).

There was a significant decrease in the concentration of Pb in the vermicomposts of all combinations of animal dungs with kitchen wastes (KW) (Table 7). Maximum decrease in the concentration of Pb in the vermicomposts obtained from the combination of sheep dung with kitchen wastes in the ratio of (1:2) was observed (87.25%, from 0.792 ± 0.004 to 0.101 ± 0.005 mg/kg) followed by horse dung with kitchen wastes in the ratio of (1:3) (86.97%, 0.783 ± 0.006 to 0.102 ± 0.004 mg/kg), buffalo dung with kitchen wastes ratio (1:1) (86.45 %, 0.598 ± 0.004 to 0.081 ± 0.007 mg/kg), goat dung with kitchen wastes in the ratio of (1:3) (76.49%, 0.655 ± 0.002 to 0.124 ± 0.003 mg/kg), cow dung with kitchen wastes in the ratio of (1:3) (75.88 %, 0.369 ± 0.005 to 0.089 ± 0.002 mg/kg) (Table 7). In other combinations of animal dungs and kitchen wastes, the percentage of decrease in the Pb level in the vermicomposts ranged between 60.80 % (in cow dung) to 75.32 % (in buffalo dung) (Figure 6).

## (4) Nickel (Ni)

The (Table 8) and (Figure 7) demonstrated that there was a significant ($P<0.05$) change in the concentration of Ni in the

vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. There was a significant decrease in the concentration of Ni in vermicomposts of all combinations of animal dungs with municipal solid wastes. It was observed that vermicomposting eliminated all the concentration of Ni from the all combination of dung's of all examined animals with municipal solid wastes decrease in the concentration of Ni was observed (78.65 %, from 0.089±0.003 to 0.019±0.003 mg/kg). In other combinations of animal dung and MSW, the percentage of decrease in the Ni level in the vermicomposts ranged between 78.65% (in MSW) to 100 % (in all combinations).

However, decrease in the concentration of Ni in the vermicomposts of most of combinations of animal dung with kitchen wastes (KW) was not more than 90% . Maximum decrease in the concentration of Ni in the vermicomposts obtained from all the combinations of goat dungwith kitchen waste was observed (Table 9) followed by buffalo dung (86.02%, 0.844 ± 0.005 to 0.118 ± 0.005 mg/kg) and horse dung with kitchen wastes in the ratio of (1:2) (80.95 %, 0.168 ± 0.004 to 0.032 ± 0.008 mg/kg). In other combinations of animal dungs and kitchen wastes, the percentage of decrease in the Ni level in the vermicomposts ranged between 50.89 % (in sheep dung) to 80.28 % in cow dung mixed with KW (Figure 8).

## (5) Cadmium (Cd)

There was a significant ($P<0.05$) decrease in the concentration of Cd in the vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. Maximum decrease in the concentration of Cd in the vermicomposts obtained from the combination of horse dung with municipal solid wastes in the ratio (1:3) was observed (95.88%, from 0.291 ± 0.003 mg/kg to 0.012 ± 0.006 mg/kg) followed by goat dung (95.14 %, 0.391 ± 0.003 to 0.019 ± 0.005 mg/kg), cow dung with municipal solid wastes in the ratio of (1:3) (94.19%, 0.258 ± 0.003 to 0.015 ± 0.004 mg/kg), buffalo dung with municipal solid wastes in the ratio of (1:1) (92.47 %, 0.292 ± 0.003 to 0.022 ± 0.002 mg/kg) and sheep dung with municipal solid wastes in the ratio of (1:2) (88.80%, 0.259 ± 0.007 to 0.029 ± 0.007 mg/kg). In other combinations of animal dungs with MSW, the percentage of decrease in the Cd level in the vermicomposts ranged between 78.26 % in horse dug to 88.61 % in cow dung (Table 10 and Figure 9).

There was a significant decrease in the concentration of Cd in the vermicomposts of all combinations of animal dungs with kitchen wastes (KW) (Table 11 and Figure 10). Maximum decrease in the concentration of Cd in the vermicomposts obtained from the combination of buffalo dung with kitchen wastes in the ratio of (1:1) was observed (85.12 %, from 0.383 ± 0.003 to 0.057 ± 0.002 mg/kg) followed by sheep dung with kitchen wastes in the ratio of (1:3) (85.04 %, 0.274 ± 0.005 to 0.041 ± 0.006 mg/kg), cow dung with kitchen wastes in the ratio of (1:1)

(84.67 %, 0.150 ± 0.006 to 0.023 ± 0.003 mg/kg), horse dung (80.12 %, 0.483 ± 0.001 to 0.096 ± 0.003 mg/kg), sheep dung with kitchen wastes ratio (1:2) (79.75%, 0.158 ± 0.008 to 0.032 ± 0.004 mg/kg). In other combinations of animal dungs and kitchen wastes, the percentage of decrease in the Cd level in the vermicomposts ranged between 53.17 % (in KW) to 78.16 % (in horse dung mixed with KW).

## (6) Arsenic (As)

Data displayed in (Table 12) and illustrated in (Figure 11) demonstrated that there was a significant ($P<0.05$) decrease in the concentration of As in the vermicomposts of different animal dungs with municipal solid wastes with respect to initial feed mixture of vermibeds. There was a significant decrease in the concentration of As in vermicomposts of all combinations of animal dungs with municipal solid wastes. Maximum decrease in the concentration of As in the vermicomposts obtained from the combination of buffalo dung was observed (91.67 %, from 0.168 ± 0.005 to 0.014 ± 0.005 mg/kg) followed by horse dung (88.89 %, 0.099 ± 0.006 to 0.011 ± 0.006 mg/kg), goat dung with municipal solid wastes in the ratio of (1:1) (87.16 %, 0.109 ± 0.003 to 0.014 ± 0.004 mg/kg). In other combinations of animal dungs and MSW, the percentage of decrease in the As level in the vermicomposts ranged between 66.04 % (in cow dung with MSW) to 80.70 % (in sheep dung with MSW).

However, there was a significant decrease in the concentration of As in the vermicomposts of all combinations of animal dungs with kitchen wastes (KW) (Table 13). Maximum decrease in the concentration of As in the vermicomposts obtained from the all combinations of cow and sheep dung with kitchen wastes in ratio (1:1, 1:2 and 1:3) was observed (100 %) followed by buffalo dung (81.55 %, 0.168 ± 0.005 to 0.031 ± 0.005 mg/kg), horse dung with kitchen wastes ratio (1:1) (79.66 %, 0.236 ± 0.005 to 0.048 ± 0.005 mg/kg), goat dung with kitchen waste (79.63% , 0.108 ± 0.004 to 0.022 ± 0.003 mg/kg). In other combinations of animal dung and kitchen wastes, the percentage of decrease in the As level in the vermicomposts ranged between 57.89% (in goat dung with kitchen waste) to 78.70 % (in buffalo dung mixed with KW). It implies that the earthworm, *Eisenia foetida* is effective in lowering down the As in dungs and KW examined during the vermicomposting more than 50% in all treatments (Figure 12).

Results demonstrated that among all the combinations of animal dung with municipal solid and kitchen wastes, the cobalt (Co) significantly ($P<0.05$) decreased in the vermicompost of combination of buffalo dung with municipal solid wastes (in the ratio of 1:1) as well as in the combination of buffalo dung with kitchen wastes (in the ratio of 1:3). Similarly, the concentration of chromium (Cr) decreased in the cow dung as well as in the combination of buffalo dung with KW in the ratio of 1:3 during vermicomposting by earthworm *Eisenia foetida*. The

amount of nickel (Ni) was decreased in the all combination of different animal dung with municipal solid wastes in the level of BDL (below detectible limit) during vermic-activity. There was significant decrease in the concentration of cadmium (Cd) in buffalo dung with municipal solid wastes (in the ratio of 1:3). The concentration of arsenic (As) was also observed significantly to decrease in the combination of cow dung with kitchen wastes in the raio of 1:1, 1:2 and 1:3 at the level of BDL (below detection limit).

Table 2: Concentration of cobalt (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.180 ± 0.006 | 0.162 ± 0.004* | 10.00 |
| Buffalo dung | - | 0.017 ± 0.007 | BDL | 100.0 |
| Buffalo dung + MSW | 1:1 | 0.029 ± 0.008 | 0.006 ± 0.003* | 79.31 |
| Buffalo dung + MSW | 1:2 | 0.037 ± 0.003 | 0.009 ± 0.002* | 75.68 |
| Buffalo dung + MSW | 1:3 | 0.035 ± 0.004 | 0.011 ± 0.004* | 68.57 |
| Cow dung | - | BDL | BDL | - |
| Cow dung + MSW | 1:1 | 0.029 ± 0.006 | 0.009 ± 0.002* | 68.97 |
| Cow dung + MSW | 1:2 | 0.062 ± 0.007 | 0.017 ± 0.003* | 72.58 |
| Cow dung + MSW | 1:3 | 0.053 ± 0.008 | 0.008 ± 0.002* | 84.91 |
| Goat dung | - | BDL | BDL | - |
| Goat dung + MSW | 1:1 | 0.022 ± 0.002 | 0.004 ± 0.003* | 81.82 |
| Goat dung + MSW | 1:2 | 0.076 ± 0.004 | 0.007 ± 0.004* | 90.79 |
| Goat dung + MSW | 1:3 | 0.068 ± 0.003 | 0.015 ± 0.003* | 77.94 |
| Horse dung | - | 0.018 ± 0.002 | 0.007 ± 0.004* | 61.11 |
| Horse dung + MSW | 1:1 | 0.025 ± 0.003 | 0.008 ± 0.008* | 68.00 |
| Horse dung + MSW | 1:2 | 0.060 ± 0.003 | 0.015 ± 0.003* | 75.00 |
| Horse dung + MSW | 1:3 | 0.079 ± 0.006 | 0.011 ± 0.005* | 86.08 |
| Sheep dung | - | 0.055 ± 0.003 | 0.027 ± 0.004* | 50.91 |
| Sheep dung + MSW | 1:1 | 0.170 ± 0.003 | 0.043 ± 0.003* | 74.71 |
| Sheep dung + MSW | 1:2 | 0.024 ± 0.003 | 0.008 ± 0.003* | 66.67 |
| Sheep dung + MSW | 1:3 | 0.061 ± 0.005 | 0.012 ± 0.005* | 80.33 |

MSW= Municipal solid wastes, BDL= below detection limit

Each value is the Mean ± SD of six replicates

* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 3: Concentration of cobalt (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.054 ± 0.006 | 0.014 ± 0.003* | 74.07 |
| Buffalo dung | - | 0.029 ± 0.008 | 0.008 ± 0.004* | 72.41 |
| Buffalo dung + KW | 1:1 | 0.029 ± 0.003 | 0.010 ± 0.003* | 65.52 |
| Buffalo dung + KW | 1:2 | 0.069 ± 0.003 | 0.028 ± 0.002* | 59.42 |
| Buffalo dung + KW | 1:3 | 0.290 ± 0.006 | 0.036 ± 0.003* | 87.59 |
| Cow dung | - | BDL | BDL | - |
| Cow dung + KW | 1:1 | BDL | BDL | - |
| Cow dung + KW | 1:2 | BDL | BDL | - |
| Cow dung + KW | 1:3 | 0.069 ± 0.001 | 0.023 ± 0.006* | 66.67 |
| Goat dung | - | 0.022 ± 0.002 | 0.007 ± 0.003* | 68.18 |
| Goat dung + KW | 1:1 | 0.037 ± 0.006 | 0.018 ± 0.004* | 51.35 |
| Goat dung + KW | 1:2 | 0.061 ± 0.005 | 0.020 ± 0.002* | 67.21 |
| Goat dung + KW | 1:3 | 0.152 ± 0.003 | 0.024 ± 0.005* | 84.21 |
| Horse dung | - | 0.018 ± 0.002 | BDL* | 100.0 |
| Horse dung + KW | 1:1 | 0.024 ± 0.004 | 0.008 ± 0.006* | 66.67 |
| Horse dung + KW | 1:2 | 0.047 ± 0.005 | 0.019 ± 0.003* | 59.57 |
| Horse dung + KW | 1:3 | 0.107 ± 0.006 | 0.037 ± 0.004* | 65.42 |
| Sheep dung | - | 0.055 ± 0.003 | 0.017 ± 0.004* | 69.09 |
| Sheep dung + KW | 1:1 | 0.155 ± 0.003 | 0.044 ± 0.004* | 71.61 |
| Sheep dung + KW | 1:2 | 0.256 ± 0.007 | 0.035 ± 0.002* | 86.33 |
| Sheep dung + KW | 1:3 | 0.281 ± 0.008 | 0.057 ± 0.006* | 79.72 |

KW = Kitchen wastes

BDL= below detection limit

Each value is the Mean ± SD of six replicates

* Significant $P<0.05$ “t” test between initial feed mixture and final vermicompost.

Table 4: Concentration of chromium (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.864 ± 0.005 | 0.141 ±0.002* | 83.68 |
| Buffalo dung | - | 0.672 ± 0.003 | 0.085 ± 0.003* | 87.35 |
| Buffalo dung + MSW | 1:1 | 0.708 ± 0.004 | 0.109 ± 0.005* | 84.60 |
| Buffalo dung + MSW | 1:2 | 0.753 ± 0.006 | 0.127 ± 0.004* | 83.13 |
| Buffalo dung + MSW | 1:3 | 0.740 ± 0.003 | 0.098 ± 0.006* | 86.76 |
| Cow dung | - | 0.848 ± 0.003 | 0.074 ± 0.003* | 91.27 |
| Cow dung + MSW | 1:1 | 0.872 ± 0.005 | 0.110 ± 0.003* | 87.39 |
| Cow dung + MSW | 1:2 | 0.749 ± 0.003 | 0.084 ± 0.005* | 88.79 |
| Cow dung + MSW | 1:3 | 0.799 ± 0.003 | 0.087 ± 0.004* | 89.11 |
| Goat dung | - | 0.860 ± 0.008 | 0.108 ± 0.004* | 87.44 |
| Goat dung + MSW | 1:1 | 0.843 ± 0.007 | 0.092 ± 0.003* | 89.09 |
| Goat dung + MSW | 1:2 | 0.906 ± 0.006 | 0.101 ± 0.003* | 88.85 |
| Goat dung + MSW | 1:3 | 0.844 ± 0.004 | 0.094 ± 0.004* | 88.86 |
| Horse dung | - | 0.795 ± 0.003 | 0.098 ± 0.005* | 87.67 |
| Horse dung + MSW | 1:1 | 0.827 ± 0.007 | 0.107 ± 0.005* | 87.06 |
| Horse dung + MSW | 1:2 | 0.802 ± 0.005 | 0.104 ± 0.003* | 87.03 |
| Horse dung + MSW | 1:3 | 0.868 ± 0.003 | 0.106 ± 0.004* | 87.79 |
| Sheep dung | - | 0.819 ± 0.005 | 0.109 ± 0.007* | 86.69 |
| Sheep dung + MSW | 1:1 | 0.821 ± 0.003 | 0.101 ± 0.006* | 87.70 |
| Sheep dung + MSW | 1:2 | 0.808 ± 0.007 | 0.097 ± 0.004* | 88.00 |
| Sheep dung + MSW | 1:3 | 0.799 ± 0.006 | 0.090 ± 0.005* | 88.74 |

MSW = municipal solid wastes
Each value is the Mean ± SD of six replicates
* Significant P<0.05 “t” test between initial feed mixture and final vermicompost.

Table 5: Concentration of chromium (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.816 ± 0.003 | 0.159 ± 0.005* | 80.51 |
| Buffalo dung | - | 1.064 ± 0.003 | 0.216 ± 0.003* | 79.70 |
| Buffalo dung + KW | 1:1 | 0.994 ± 0.008 | 0.144 ± 0.002* | 85.51 |
| Buffalo dung + KW | 1:2 | 0.872 ± 0.002 | 0.123 ± 0.003* | 85.89 |
| Buffalo dung + KW | 1:3 | 0.786 ± 0.006 | 0.062 ± 0.003* | 92.11 |
| Cow dung | - | 0.848 ± 0.003 | 0.124 ± 0.003* | 85.38 |
| Cow dung + KW | 1:1 | 0.766 ± 0.004 | 0.081 ± 0.004* | 89.43 |
| Cow dung + KW | 1:2 | 0.783 ± 0.009 | 0.090 ± 0.005* | 88.51 |
| Cow dung + KW | 1:3 | 0.802 ± 0.007 | 0.108 ± 0.004* | 86.53 |
| Goat dung | - | 0.472 ± 0.008 | 0.109 ± 0.004* | 76.91 |
| Goat dung + KW | 1:1 | 0.443 ± 0.005 | 0.084 ± 0.003* | 81.04 |
| Goat dung + KW | 1:2 | 0.643 ± 0.004 | 0.105 ± 0.005* | 83.67 |
| Goat dung + KW | 1:3 | 0.885 ± 0.003 | 0.112 ± 0.004* | 87.34 |
| Horse dung | - | 0.795 ± 0.003 | 0.109 ± 0.005* | 86.29 |
| Horse dung + KW | 1:1 | 0.757 ± 0.004 | 0.102 ± 0.007* | 86.53 |
| Horse dung + KW | 1:2 | 0.872 ± 0.006 | 0.122 ± 0.004* | 86.01 |
| Horse dung + KW | 1:3 | 0.808 ± 0.007 | 0.118 ± 0.004* | 85.40 |
| Sheep dung | - | 0.819 ± 0.005 | 0.113 ± 0.007* | 86.20 |
| Sheep dung + KW | 1:1 | 0.830 ± 0.005 | 0.124 ± 0.005* | 85.06 |
| Sheep dung + KW | 1:2 | 0.608 ± 0.008 | 0.095 ± 0.004* | 84.38 |
| Sheep dung + KW | 1:3 | 0.770 ± 0.006 | 0.102 ± 0.006* | 86.75 |

KW = Kitchen wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 6: Concentration of lead (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.965 ± 0.003 | 0.063 ± 0.003* | 93.47 |
| Buffalo dung | - | BDL | BDL | - |
| Buffalo dung + MSW | 1:1 | 1.773 ± 0.008 | 0.058 ± 0.003* | 96.73 |
| Buffalo dung + MSW | 1:2 | 0.185 ± 0.005 | 0.034 ± 0.003* | 81.62 |
| Buffalo dung + MSW | 1:3 | 0.782 ± 0.006 | 0.043 ± 0.003* | 94.50 |
| Cow dung | - | 0.024 ± 0.004 | 0.008 ± 0.006* | 66.67 |
| Cow dung + MSW | 1:1 | 0.030 ± 0.005 | 0.011 ± 0.005* | 63.33 |
| Cow dung + MSW | 1:2 | 0.088 ± 0.003 | 0.018 ± 0.004* | 79.55 |
| Cow dung + MSW | 1:3 | 0.092 ± 0.004 | 0.023 ± 0.003* | 75.00 |
| Goat dung | - | BDL | BDL | - |
| Goat dung + MSW | 1:1 | 0.184 ± 0.004 | 0.042 ± 0.003* | 77.17 |
| Goat dung + MSW | 1:2 | 1.674 ± 0.004 | 0.109 ± 0.003* | 93.49 |
| Goat dung + MSW | 1:3 | 0.278 ± 0.005 | 0.057 ± 0.003* | 79.50 |
| Horse dung | - | 0.199 ± 0.002 | 0.038 ± 0.003* | 80.90 |
| Horse dung + MSW | 1:1 | 0.108 ± 0.003 | 0.029 ± 0.008* | 73.15 |
| Horse dung + MSW | 1:2 | 0.069 ± 0.003 | 0.026 ± 0.007* | 62.32 |
| Horse dung + MSW | 1:3 | 0.058 ± 0.004 | 0.015 ± 0.004* | 74.14 |
| Sheep dung | - | 0.748 ± 0.005 | 0.046 ± 0.004* | 93.85 |
| Sheep dung + MSW | 1:1 | 0.573 ± 0.004 | 0.035 ± 0.003* | 93.89 |
| Sheep dung + MSW | 1:2 | 0.906 ± 0.006 | 0.112 ± 0.006* | 87.64 |
| Sheep dung + MSW | 1:3 | 0.757 ± 0.007 | 0.033 ± 0.005* | 95.64 |

MSW = Municipal solid wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 7: Concentration of lead (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.345 ± 0.005 | 0.120 ± 0.004* | 65.22 |
| Buffalo dung | - | 0.782 ± 0.006 | 0.193 ± 0.003* | 75.32 |
| Buffalo dung + KW | 1:1 | 0.598 ± 0.004 | 0.081 ± 0.007* | 86.45 |
| Buffalo dung + KW | 1:2 | 0.653 ± 0.003 | 0.096 ± 0.005* | 85.30 |
| Buffalo dung + KW | 1:3 | 1.692 ± 0.004 | 0.287 ± 0.002* | 83.04 |
| Cow dung | - | 0.199 ± 0.002 | 0.078 ± 0.003* | 60.80 |
| Cow dung + KW | 1:1 | 0.193 ± 0.005 | 0.054 ± 0.005* | 72.02 |
| Cow dung + KW | 1:2 | 0.224 ± 0.006 | 0.062 ± 0.006* | 72.32 |
| Cow dung + KW | 1:3 | 0.369 ± 0.005 | 0.089 ± 0.002* | 75.88 |
| Goat dung | - | 0.184 ± 0.004 | 0.062 ± 0.003* | 66.30 |
| Goat dung + KW | 1:1 | 0.175 ± 0.007 | 0.057 ± 0.004* | 67.43 |
| Goat dung + KW | 1:2 | 0.336 ± 0.003 | 0.088 ± 0.004* | 73.81 |
| Goat dung + KW | 1:3 | 0.655 ± 0.002 | 0.154 ± 0.002* | 76.49 |
| Horse dung | - | 0.024 ± 0.004 | 0.008 ± 0.006* | 66.67 |
| Horse dung + KW | 1:1 | 0.093 ± 0.005 | 0.031 ± 0.003* | 66.67 |
| Horse dung + KW | 1:2 | 0.158 ± 0.004 | 0.054 ± 0.004* | 65.82 |
| Horse dung + KW | 1:3 | 0.783 ± 0.006 | 0.102 ± 0.004* | 86.97 |
| Sheep dung | - | 0.748 ± 0.005 | 0.106 ± 0.004* | 85.83 |
| Sheep dung + KW | 1:1 | 0.593 ± 0.003 | 0.103 ± 0.004* | 82.63 |
| Sheep dung + KW | 1:2 | 0.792 ± 0.004 | 0.101 ± 0.005* | 87.25 |
| Sheep dung + KW | 1:3 | 0.886 ± 0.008 | 0.124 ± 0.003* | 86.00 |

KW = municipal solid wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 8: Concentration of nickel (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.089 ± 0.003 | 0.019 ± 0.003* | 78.65 |
| Buffalo dung | - | 0.126 ± 0.003 | BDL* | 100.0 |
| Buffalo dung + MSW | 1:1 | 0.100 ± 0.003 | BDL* | 100.0 |
| Buffalo dung + MSW | 1:2 | 0.093 ± 0.003 | BDL* | 100.0 |
| Buffalo dung + MSW | 1:3 | 0.109 ± 0.004 | BDL* | 100.0 |
| Cow dung | - | 0.107 ± 0.005 | BDL* | 100.0 |
| Cow dung + MSW | 1:1 | 0.192 ± 0.004 | BDL* | 100.0 |
| Cow dung + MSW | 1:2 | 0.124 ± 0.007 | BDL* | 100.0 |
| Cow dung + MSW | 1:3 | 0.128 ± 0.005 | BDL* | 100.0 |
| Goat dung | - | 0.844 ± 0.005 | BDL* | 100.0 |
| Goat dung + MSW | 1:1 | 0.115 ± 0.004 | BDL* | 100.0 |
| Goat dung + MSW | 1:2 | 0.117 ± 0.008 | BDL* | 100.0 |
| Goat dung + MSW | 1:3 | 0.090 ± 0.004 | BDL* | 100.0 |
| Horse dung | - | 0.106 ± 0.003 | BDL* | 100.0 |
| Horse dung + MSW | 1:1 | 0.077 ± 0.007 | BDL* | 100.0 |
| Horse dung + MSW | 1:2 | 0.095 ± 0.003 | BDL* | 100.0 |
| Horse dung + MSW | 1:3 | 0.092 ± 0.003 | BDL* | 100.0 |
| Sheep dung | - | 0.172 ± 0.00 | BDL* | 100.0 |
| Sheep dung + MSW | 1:1 | 0.108 ± 0.007 | BDL* | 100.0 |
| Sheep dung + MSW | 1:2 | 0.101 ± 0.003 | BDL* | 100.0 |
| Sheep dung + MSW | 1:3 | 0.086 ± 0.002 | BDL* | 100.0 |

MSW = Municipal solid wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 9: Concentration of nickel (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.174 ± 0.003 | 0.035 ± 0.004* | 79.89 |
| Buffalo dung | - | 0.844 ± 0.005 | 0.118 ± 0.005* | 86.02 |
| Buffalo dung + KW | 1:1 | 0.908 ± 0.005 | 0.153 ± 0.003* | 83.15 |
| Buffalo dung + KW | 1:2 | 0.842 ± 0.003 | 0.147 ± 0.004* | 82.54 |
| Buffalo dung + KW | 1:3 | 0.768 ± 0.003 | 0.136 ± 0.004* | 82.29 |
| Cow dung | - | 0.116 ± 0.003 | 0.028 ± 0.003* | 75.86 |
| Cow dung + KW | 1:1 | 0.105 ± 0.007 | 0.026 ± 0.004* | 75.24 |
| Cow dung + KW | 1:2 | 0.134 ± 0.005 | 0.033 ± 0.002* | 75.37 |
| Cow dung + KW | 1:3 | 0.289 ± 0.004 | 0.057 ± 0.003* | 80.28 |
| Goat dung | - | 0.107 ± 0.005 | BDL * | 100.0 |
| Goat dung + KW | 1:1 | 0.086 ± 0.002 | BDL * | 100.0 |
| Goat dung + KW | 1:2 | 0.094 ± 0.005 | BDL * | 100.0 |
| Goat dung + KW | 1:3 | 0.100 ± 0.003 | BDL* | 100.0 |
| Horse dung | - | 0.106 ± 0.003 | 0.029 ± 0.005* | 72.64 |
| Horse dung + KW | 1:1 | 0.117 ± 0.003 | 0.035 ± 0.006* | 70.09 |
| Horse dung + KW | 1:2 | 0.168 ± 0.004 | 0.032 ± 0.008* | 80.95 |
| Horse dung + KW | 1:3 | 0.254 ± 0.005 | 0.108 ± 0.002* | 57.48 |
| Sheep dung | - | 0.112 ± 0.005 | 0.055 ± 0.005* | 50.89 |
| Sheep dung + KW | 1:1 | 0.104 ± 0.003 | 0.032 ± 0.003* | 69.23 |
| Sheep dung + KW | 1:2 | 0.133 ± 0.003 | 0.028 ± 0.004* | 78.95 |
| Sheep dung + KW | 1:3 | 0.276 ± 0.002 | 0.066 ± 0.002* | 76.09 |

KW = municipal solid wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 10: Concentration of cadmium (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.287 ± 0.003 | 0.027 ± 0.004* | 90.59 |
| Buffalo dung | - | 0.398 ± 0.006 | 0.041 ± 0.004* | 89.70 |
| Buffalo dung + MSW | 1:1 | 0.292 ± 0.003 | 0.022 ± 0.002* | 92.47 |
| Buffalo dung + MSW | 1:2 | 0.087 ± 0.002 | 0.016 ± 0.004* | 81.61 |
| Buffalo dung + MSW | 1:3 | 0.080 ± 0.006 | 0.014 ± 0.005* | 82.50 |
| Cow dung | - | 0.158 ± 0.005 | 0.018 ± 0.005* | 88.61 |
| Cow dung + MSW | 1:1 | 0.090 ± 0.007 | 0.009 ± 0.002* | 90.00 |
| Cow dung + MSW | 1:2 | 0.828 ± 0.008 | 0.118 ± 0.003* | 85.75 |
| Cow dung + MSW | 1:3 | 0.258 ± 0.003 | 0.015 ± 0.004* | 94.19 |
| Goat dung | - | 0.391 ± 0.003 | 0.019 ± 0.005* | 95.14 |
| Goat dung + MSW | 1:1 | 0.450 ± 0.004 | 0.028 ± 0.005* | 93.78 |
| Goat dung + MSW | 1:2 | 0.166 ± 0.001 | 0.021 ± 0.002* | 87.35 |
| Goat dung + MSW | 1:3 | 0.137 ± 0.004 | 0.017 ± 0.003* | 87.59 |
| Horse dung | - | 0.483 ± 0.001 | 0.105 ± 0.003* | 78.26 |
| Horse dung + MSW | 1:1 | 0.258 ± 0.004 | 0.024 ± 0.004* | 90.70 |
| Horse dung + MSW | 1:2 | 0.312 ± 0.008 | 0.019 ± 0.004* | 93.91 |
| Horse dung + MSW | 1:3 | 0.291 ± 0.003 | 0.012 ± 0.006* | 95.88 |
| Sheep dung | - | 0.288 ± 0.004 | 0.037 ± 0.003* | 87.15 |
| Sheep dung + MSW | 1:1 | 0.218 ± 0.006 | 0.028 ± 0.005* | 87.16 |
| Sheep dung + MSW | 1:2 | 0.259 ± 0.007 | 0.029 ± 0.007* | 88.80 |
| Sheep dung + MSW | 1:3 | 0.193 ± 0.003 | 0.025 ± 0.006* | 87.05 |

MSW = municipal solid wastes
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 11: Concentration of cadmium (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.126 ± 0.005 | 0.059 ± 0.006* | 53.17 |
| Buffalo dung | - | 0.398 ± 0.006 | 0.061 ± 0.004* | 84.67 |
| Buffalo dung + KW | 1:1 | 0.383 ± 0.003 | 0.057 ± 0.002* | 85.12 |
| Buffalo dung + KW | 1:2 | 0.258 ± 0.004 | 0.052 ± 0.006* | 79.84 |
| Buffalo dung + KW | 1:3 | 0.174 ± 0.004 | 0.034 ± 0.003* | 80.46 |
| Cow dung | - | 0.158 ± 0.005 | 0.028 ± 0.005* | 82.28 |
| Cow dung + KW | 1:1 | 0.150 ± 0.006 | 0.023 ± 0.003* | 84.67 |
| Cow dung + KW | 1:2 | 0.174 ± 0.003 | 0.049 ± 0.002* | 71.84 |
| Cow dung + KW | 1:3 | 0.189 ± 0.005 | 0.060 ± 0.003* | 68.25 |
| Goat dung | - | 0.391 ± 0.003 | 0.108 ± 0.005* | 72.38 |
| Goat dung + KW | 1:1 | 0.114 ± 0.003 | 0.043 ± 0.004* | 62.28 |
| Goat dung + KW | 1:2 | 0.178 ± 0.001 | 0.055 ± 0.004* | 69.10 |
| Goat dung + KW | 1:3 | 0.218 ± 0.002 | 0.092 ± 0.006* | 57.80 |
| Horse dung | - | 0.483 ± 0.001 | 0.096 ± 0.003* | 80.12 |
| Horse dung + KW | 1:1 | 0.384 ± 0.004 | 0.103 ± 0.003* | 73.18 |
| Horse dung + KW | 1:2 | 0.174 ± 0.004 | 0.038 ± 0.005* | 78.16 |
| Horse dung + KW | 1:3 | 0.135 ± 0.003 | 0.032 ± 0.004* | 76.30 |
| Sheep dung | - | 0.288 ± 0.004 | 0.067 ± 0.003* | 76.74 |
| Sheep dung + KW | 1:1 | 0.133 ± 0.006 | 0.059 ± 0.005* | 55.64 |
| Sheep dung + KW | 1:2 | 0.158 ± 0.008 | 0.032 ± 0.004* | 79.75 |
| Sheep dung + KW | 1:3 | 0.274 ± 0.005 | 0.041 ± 0.006* | 85.04 |

KW = municipal solid wastes
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 12: Concentration of arsenic (mg/kg) in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| MSW | - | 0.081 ± 0.008 | 0.026 ± 0.003* | 67.90 |
| Buffalo dung | - | 0.168 ± 0.005 | 0.014 ± 0.005* | 91.67 |
| Buffalo dung + MSW | 1:1 | 0.091 ± 0.005 | 0.012 ± 0.003* | 86.81 |
| Buffalo dung + MSW | 1:2 | 0.083 ± 0.003 | 0.016 ± 0.002* | 80.72 |
| Buffalo dung + MSW | 1:3 | 0.102 ± 0.001 | 0.027 ± 0.003* | 73.53 |
| Cow dung | - | 0.057 ± 0.004 | 0.019 ± 0.005* | 66.67 |
| Cow dung + MSW | 1:1 | 0.053 ± 0.008 | 0.018 ± 0.002* | 66.04 |
| Cow dung + MSW | 1:2 | 0.058 ± 0.005 | 0.015 ± 0.004* | 74.14 |
| Cow dung + MSW | 1:3 | 0.075 ± 0.003 | 0.025 ± 0.003* | 66.67 |
| Goat dung | - | 0.118 ± 0.005 | 0.016 ± 0.003* | 86.44 |
| Goat dung + MSW | 1:1 | 0.109 ± 0.003 | 0.014 ± 0.004* | 87.16 |
| Goat dung + MSW | 1:2 | 0.059 ± 0.003 | 0.009 ± 0.003* | 84.75 |
| Goat dung + MSW | 1:3 | 0.040 ± 0.002 | 0.006 ± 0.002* | 85.00 |
| Horse dung | - | 0.099 ± 0.006 | 0.011 ± 0.006* | 88.89 |
| Horse dung + MSW | 1:1 | 0.098 ± 0.005 | 0.016 ± 0.007* | 83.67 |
| Horse dung + MSW | 1:2 | 0.079 ± 0.003 | 0.012 ± 0.004* | 84.81 |
| Horse dung + MSW | 1:3 | 0.061 ± 0.007 | 0.015 ± 0.005* | 75.41 |
| Sheep dung | - | 0.061 ± 0.004 | 0.016 ± 0.004* | 73.77 |
| Sheep dung + MSW | 1:1 | 0.053 ± 0.008 | 0.013 ± 0.008* | 75.47 |
| Sheep dung + MSW | 1:2 | 0.067 ± 0.003 | 0.015 ± 0.002* | 77.61 |
| Sheep dung + MSW | 1:3 | 0.057 ± 0.005 | 0.011 ± 0.005* | 80.70 |

MSW = municipal solid wastes
Each value is the Mean ± SD of six replicates
* Significant $P<0.05$ "t" test between initial feed mixture and final vermicompost.

Table 13: Concentration of arsenic (mg/kg) in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

| Vermicompost | Ratio | Initial | Final | % decrease |
|---|---|---|---|---|
| KW | - | 0.167 ± 0.003 | 0.036 ± 0.004* | 78.44 |
| Buffalo dung | - | 0.168 ± 0.005 | 0.031 ± 0.005* | 81.55 |
| Buffalo dung + KW | 1:1 | 0.178 ± 0.004 | 0.043 ± 0.006* | 75.84 |
| Buffalo dung + KW | 1:2 | 0.216 ± 0.006 | 0.046 ± 0.004* | 78.70 |
| Buffalo dung + KW | 1:3 | 0.269 ± 0.003 | 0.052 ± 0.004* | 80.67 |
| Cow dung | - | 0.057 ± 0.004 | BDL * | 100.0 |
| Cow dung + KW | 1:1 | 0.052 ± 0.002 | BDL * | 100.0 |
| Cow dung + KW | 1:2 | 0.067 ± 0.003 | BDL * | 100.0 |
| Cow dung + KW | 1:3 | 0.152 ± 0.002 | 0.041 ± 0.004* | 73.03 |
| Goat dung | - | 0.118 ± 0.005 | 0.037 ± 0.003* | 68.64 |
| Goat dung + KW | 1:1 | 0.076 ± 0.003 | 0.032 ± 0.004* | 57.89 |
| Goat dung + KW | 1:2 | 0.079 ± 0.002 | 0.029 ± 0.003* | 63.29 |
| Goat dung + KW | 1:3 | 0.108 ± 0.004 | 0.022 ± 0.003* | 79.63 |
| Horse dung | - | 0.099 ± 0.006 | 0.025 ± 0.006* | 74.75 |
| Horse dung + KW | 1:1 | 0.236 ± 0.005 | 0.048 ± 0.005* | 79.66 |
| Horse dung + KW | 1:2 | 0.142 ± 0.004 | 0.036 ± 0.006* | 74.65 |
| Horse dung + KW | 1:3 | 0.200 ± 0.003 | 0.051 ± 0.003* | 74.50 |
| Sheep dung | - | 0.061 ± 0.004 | BDL* | 100.0 |
| Sheep dung + KW | 1:1 | 0.052 ± 0.003 | BDL* | 100.0 |
| Sheep dung + KW | 1:2 | 0.053 ± 0.005 | BDL* | 100.0 |
| Sheep dung + KW | 1:3 | 0.040 ± 0.003 | BDL* | 100.0 |

KW = municipal solid wastes
BDL= below detection limit
Each value is the Mean ± SD of six replicates
* Significant P<0.05 “t” test between initial feed mixture and final vermicompost.

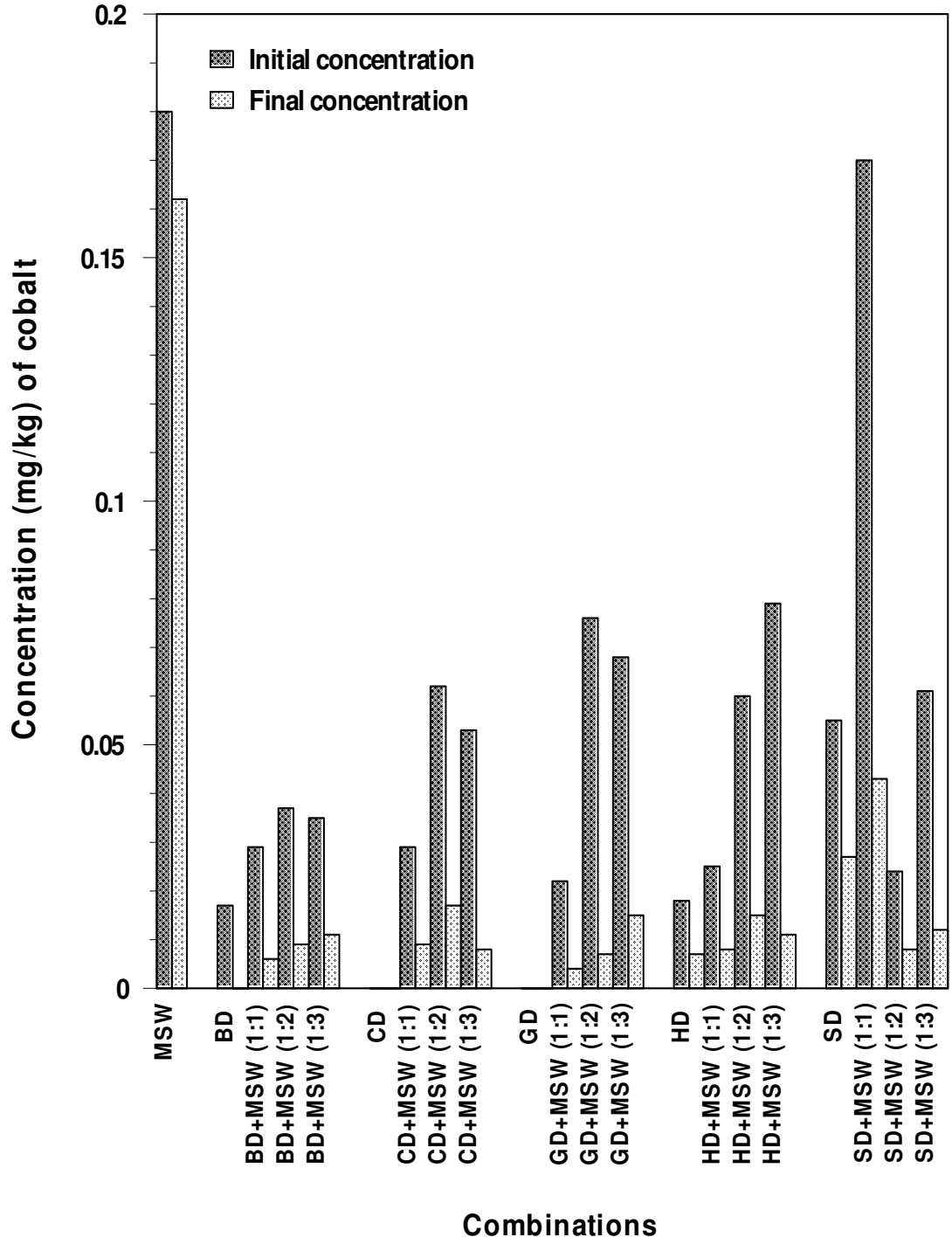



Figure 1. Concentration (mg/kg) of cobalt in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

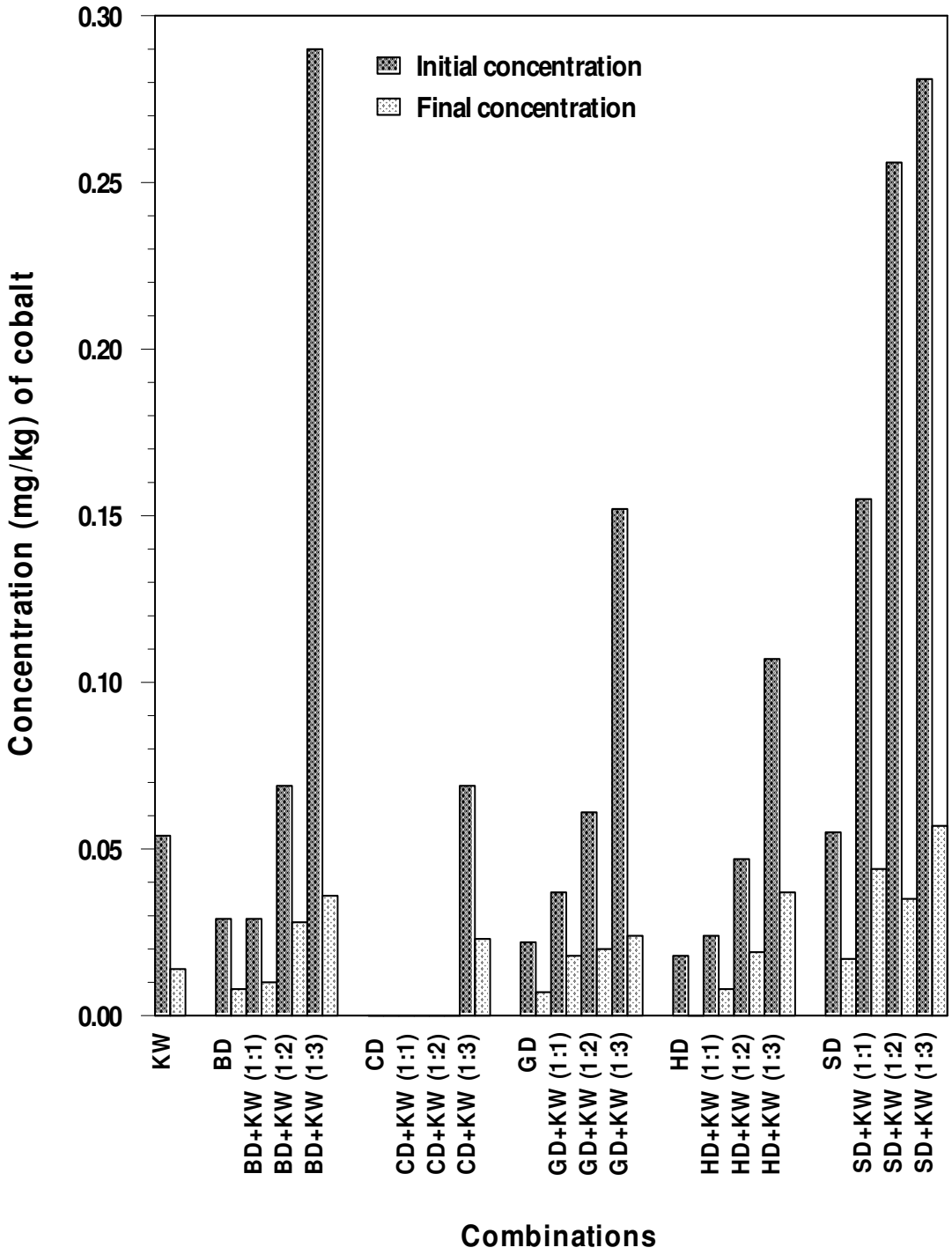



Figure 2. Concentration (mg/kg) of cobalt in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

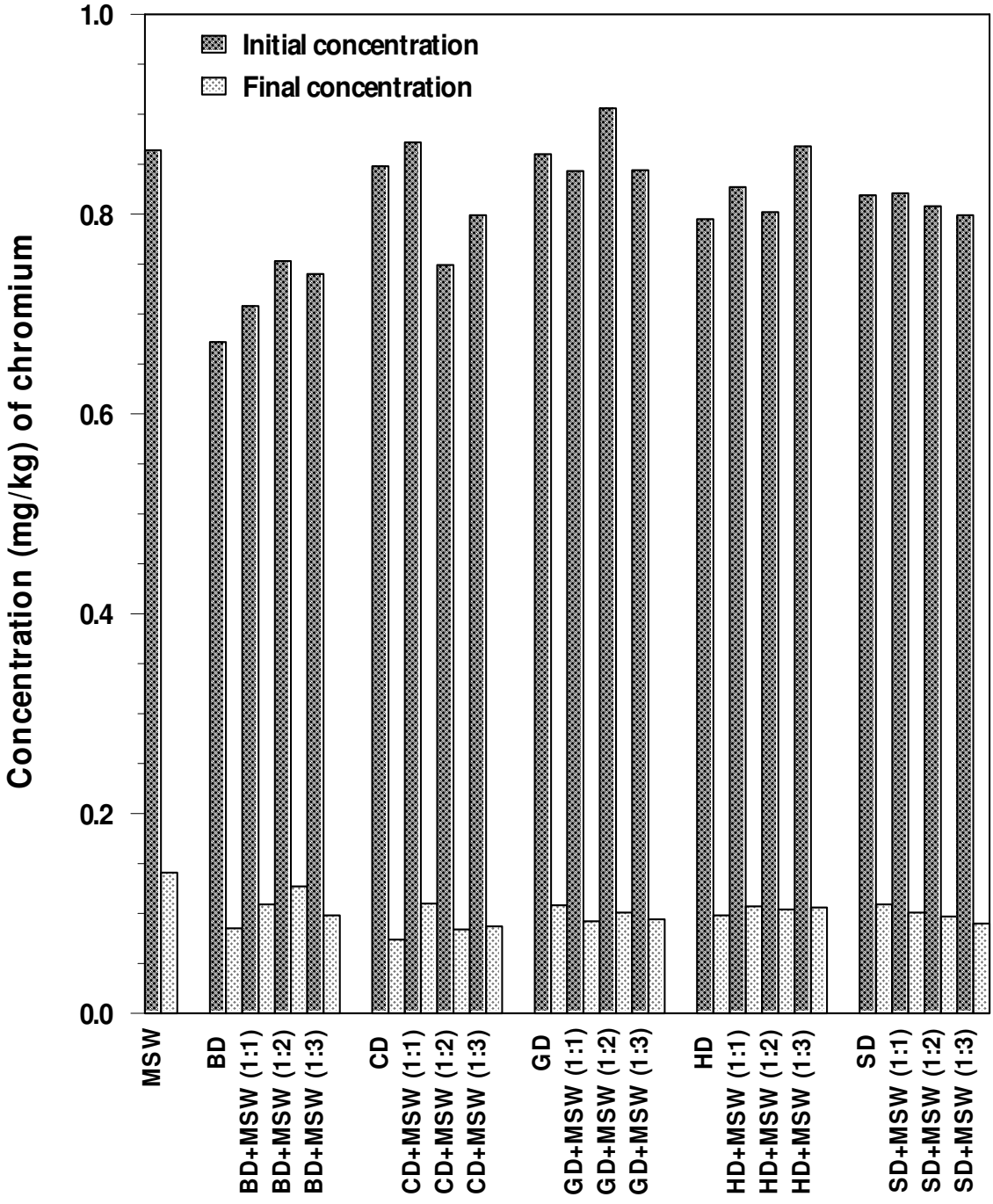



Figure 3. Concentration (mg/kg) of chromium in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

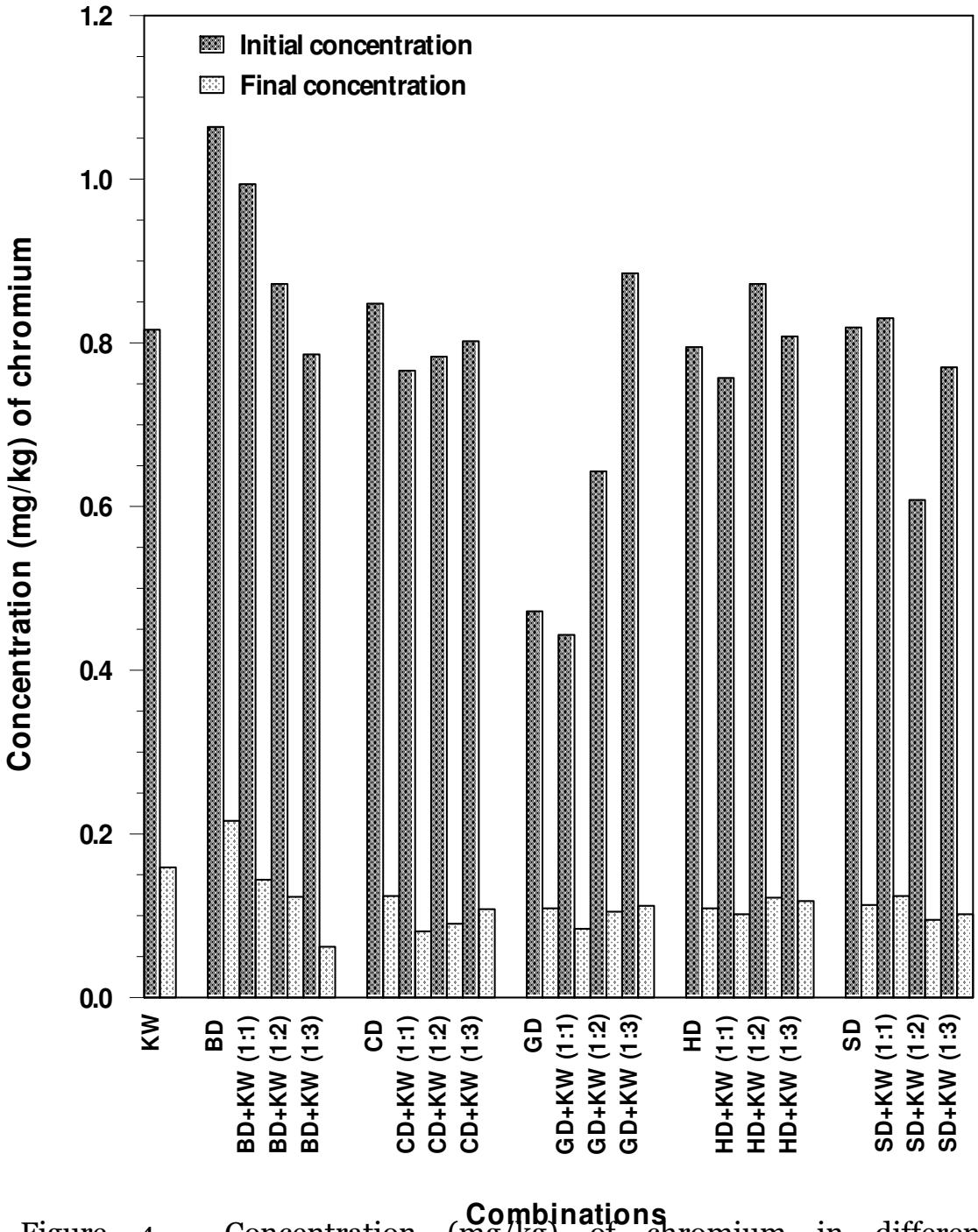



Figure 4. Concentration (mg/kg) of chromium in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

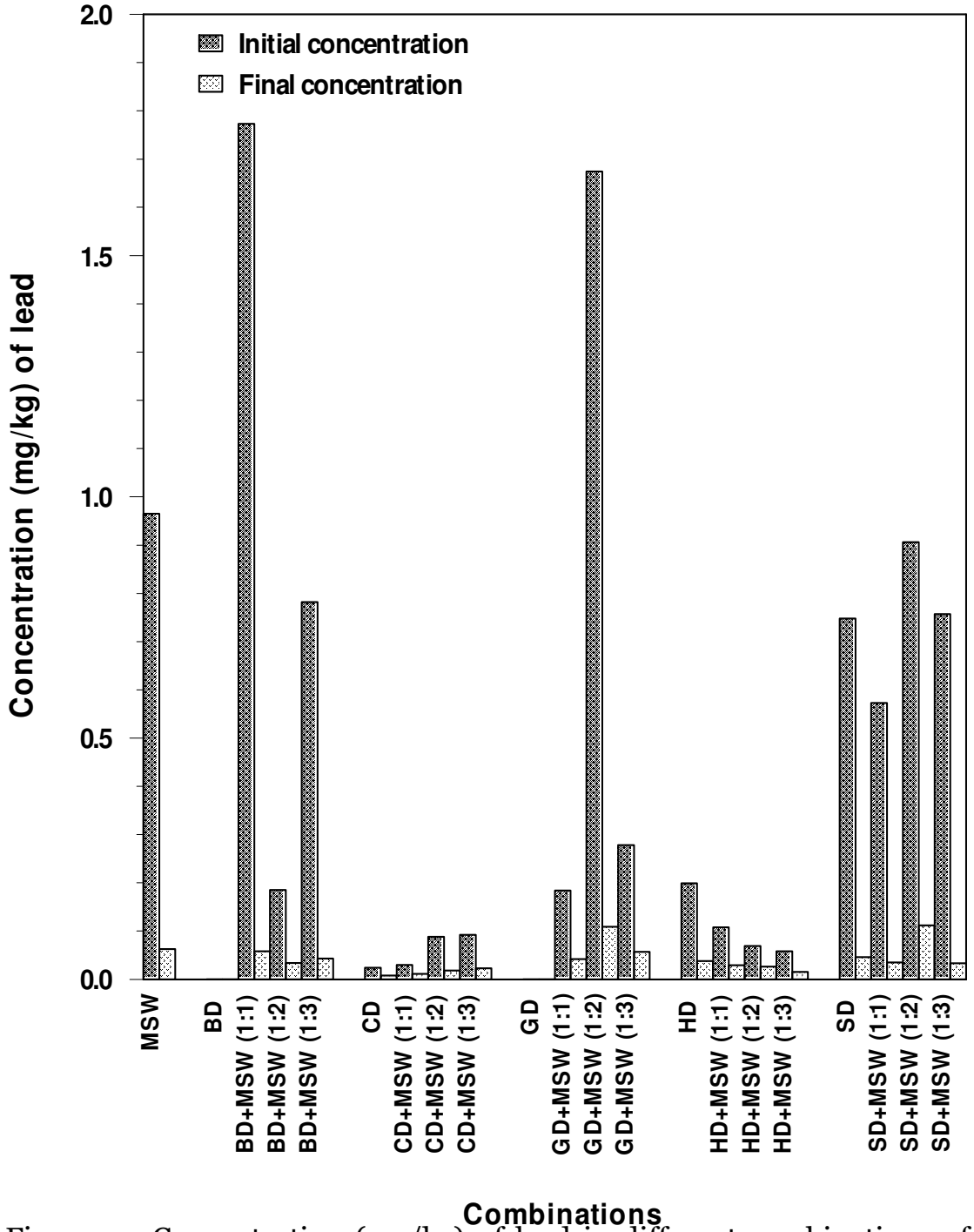



Figure 5. Concentration (mg/kg) of lead in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

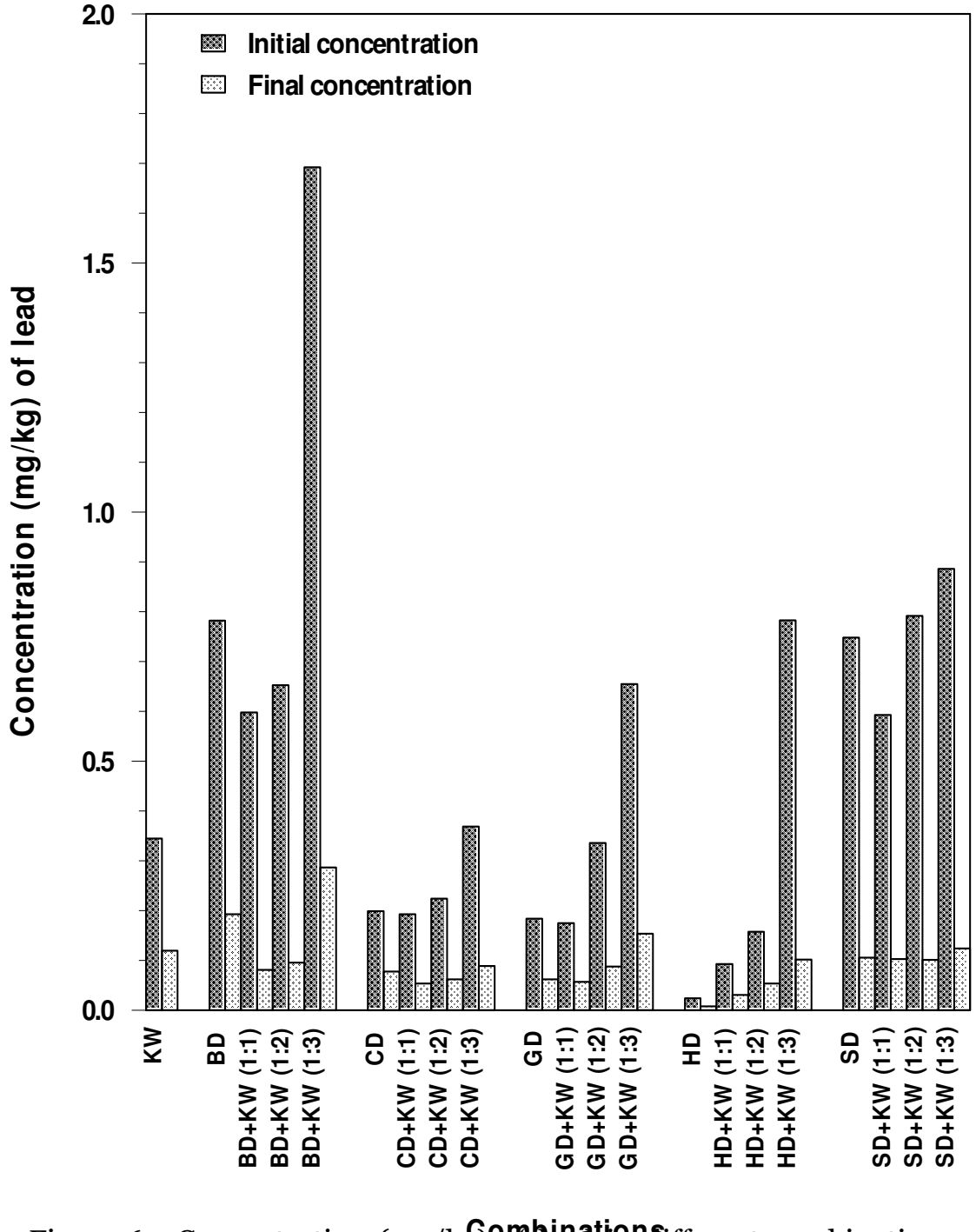



Figure 6. Concentration (mg/kg) of lead in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

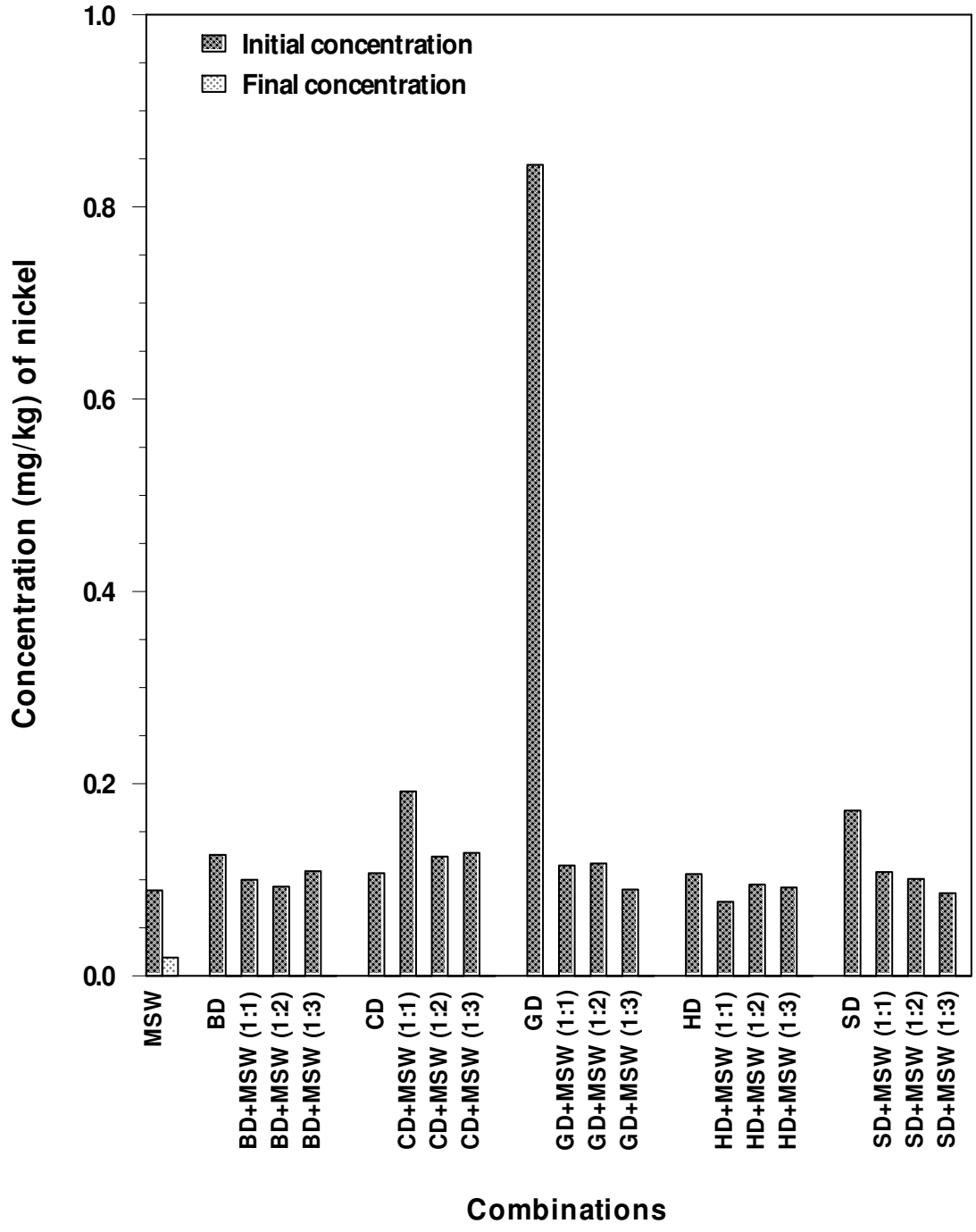



Figure 7. Concentration (mg/kg) of nickel in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

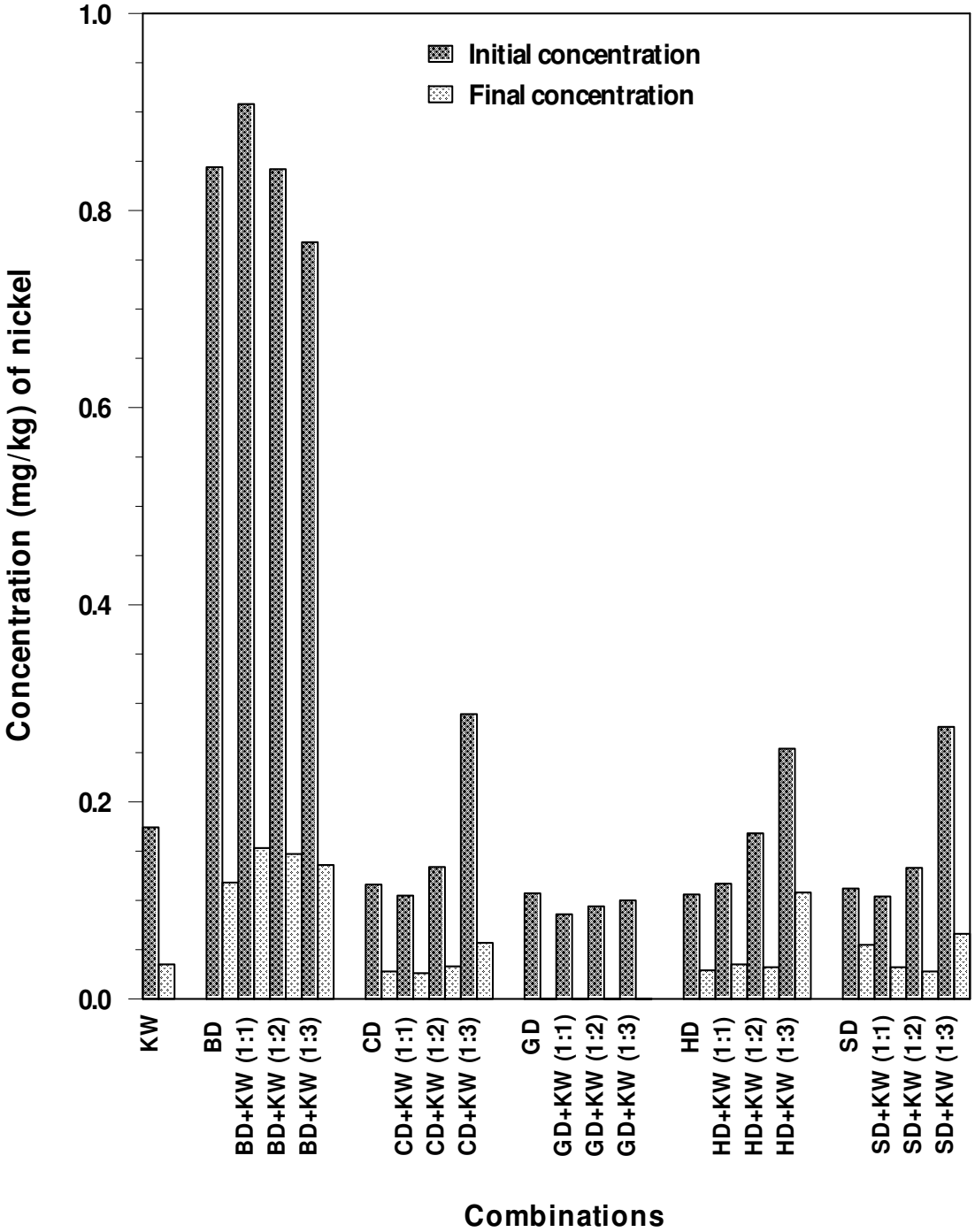



Figure 8. Concentration (mg/kg) of nickel in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

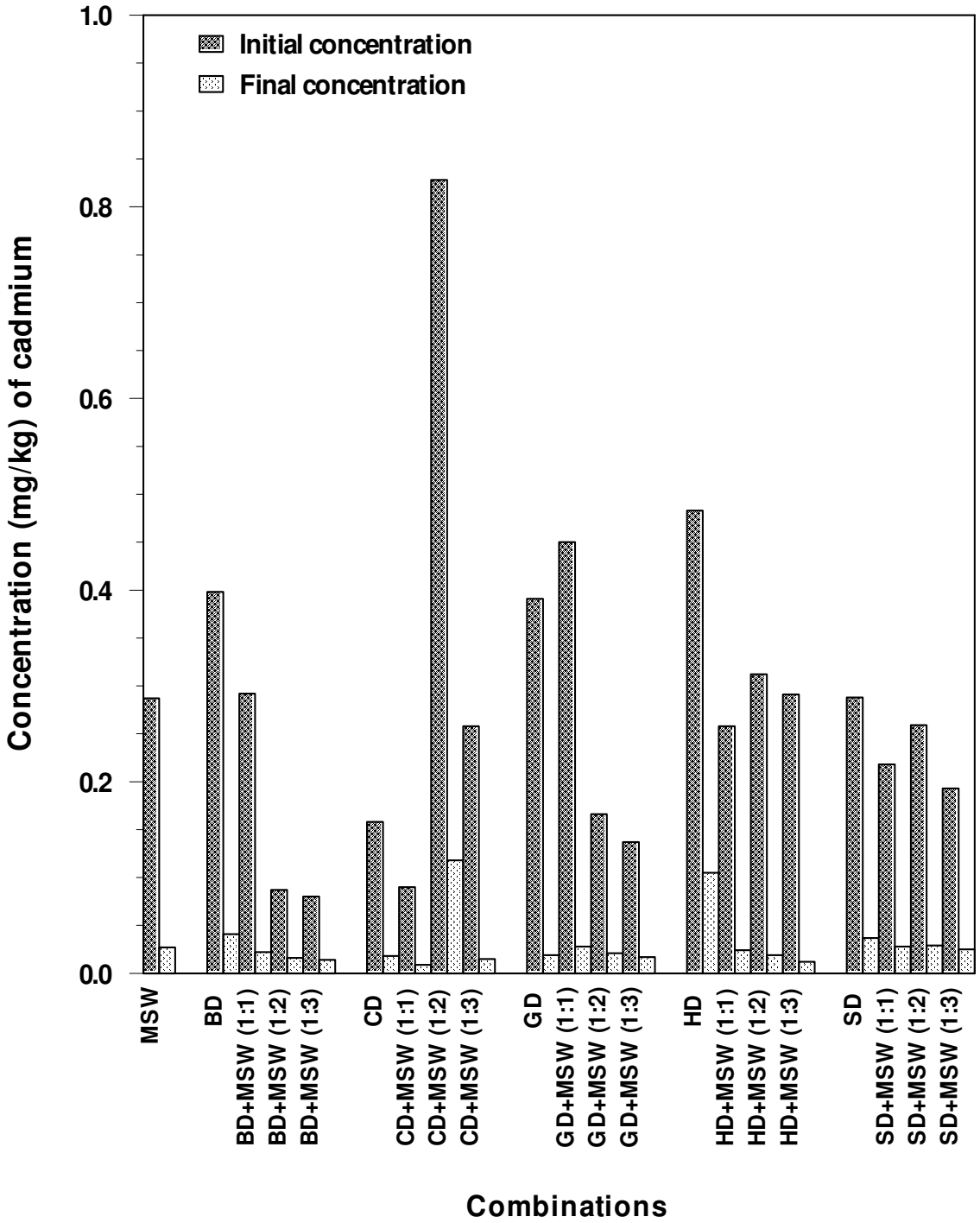



Figure 9. Concentration (mg/kg) of cadmium in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

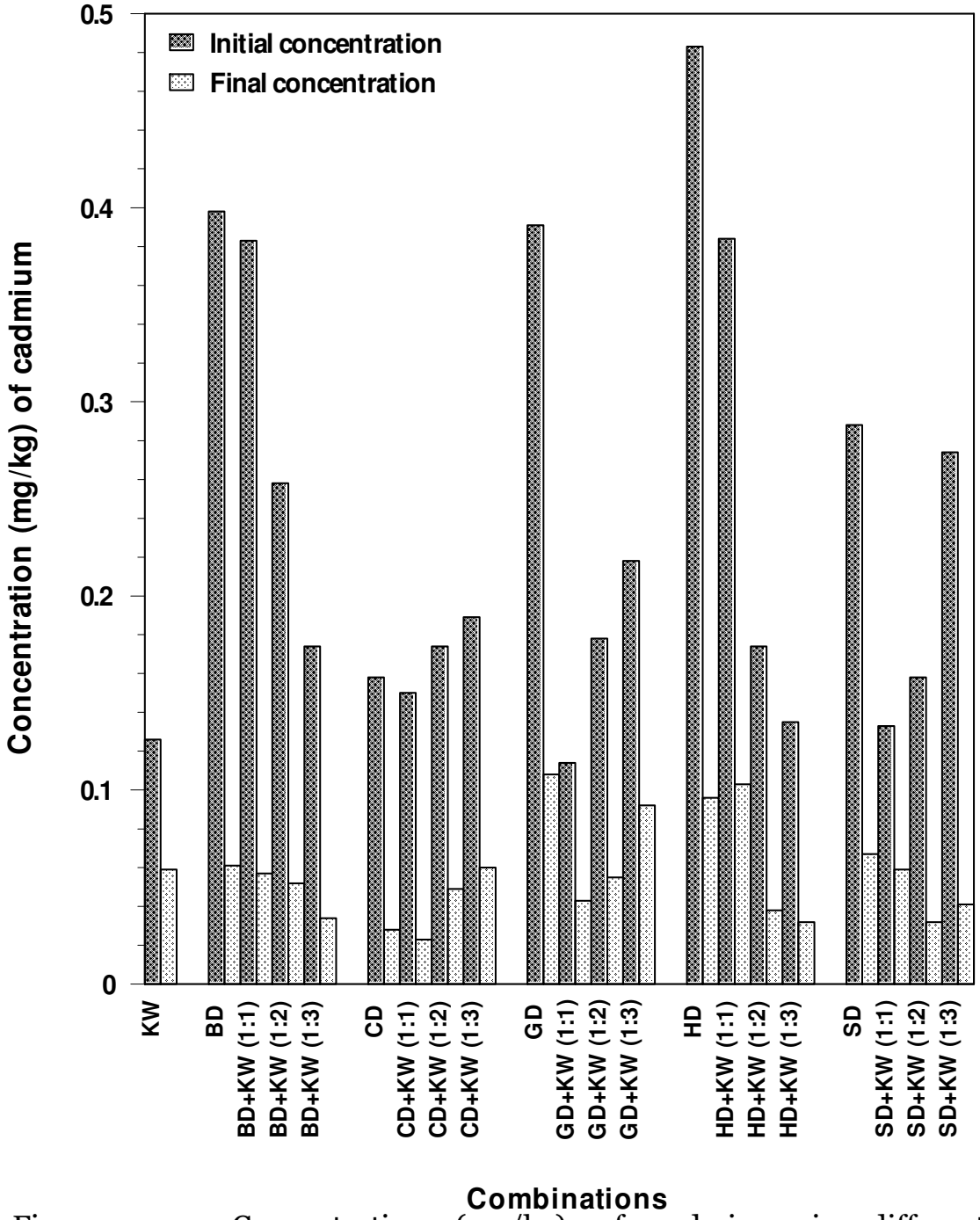



Figure 10. Concentration (mg/kg) of cadmium in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

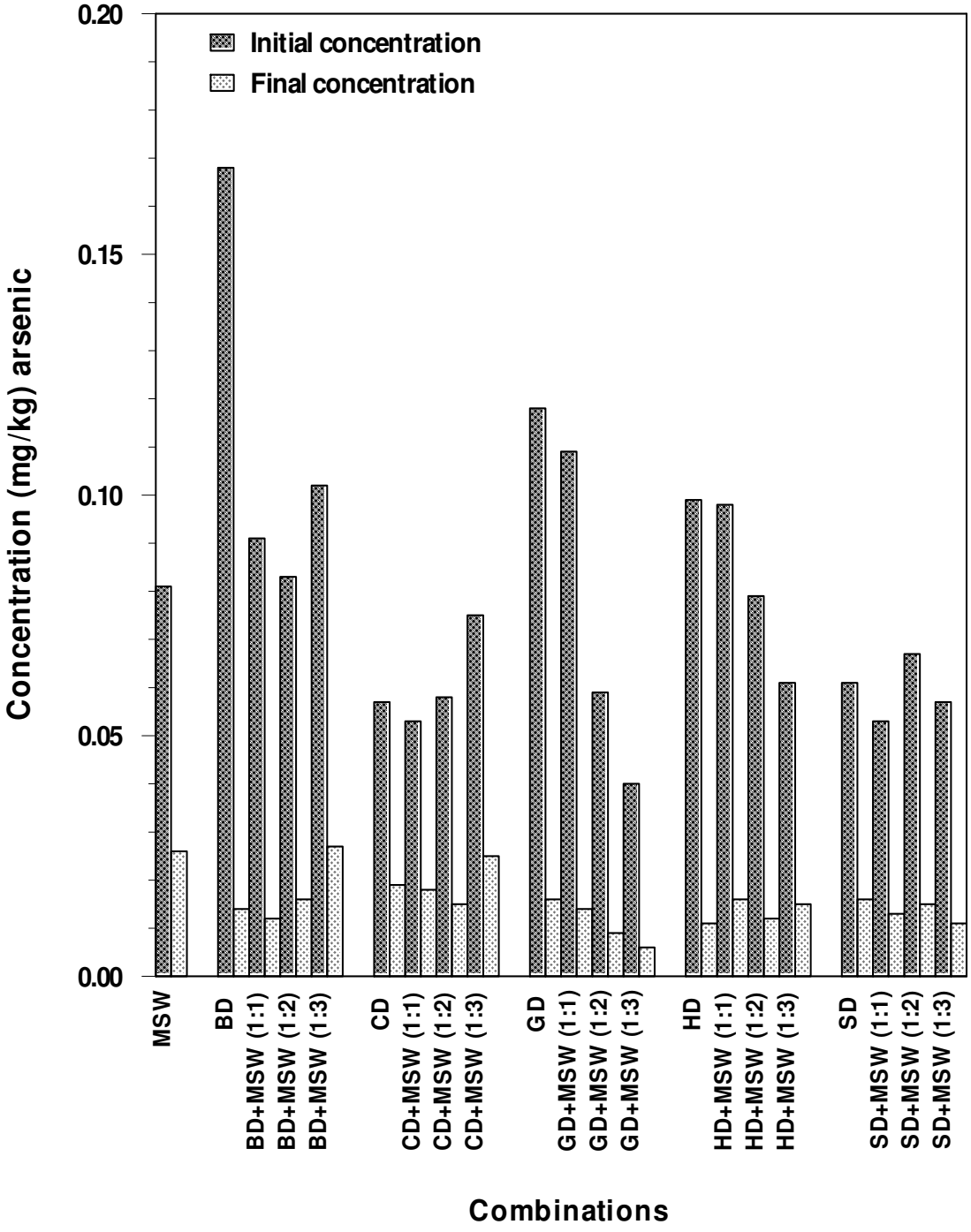



Figure 11. Concentration (mg/kg) of arsenic in different combinations of animal dung with municipal solid wastes in initial feed mixture and final vermicompost.

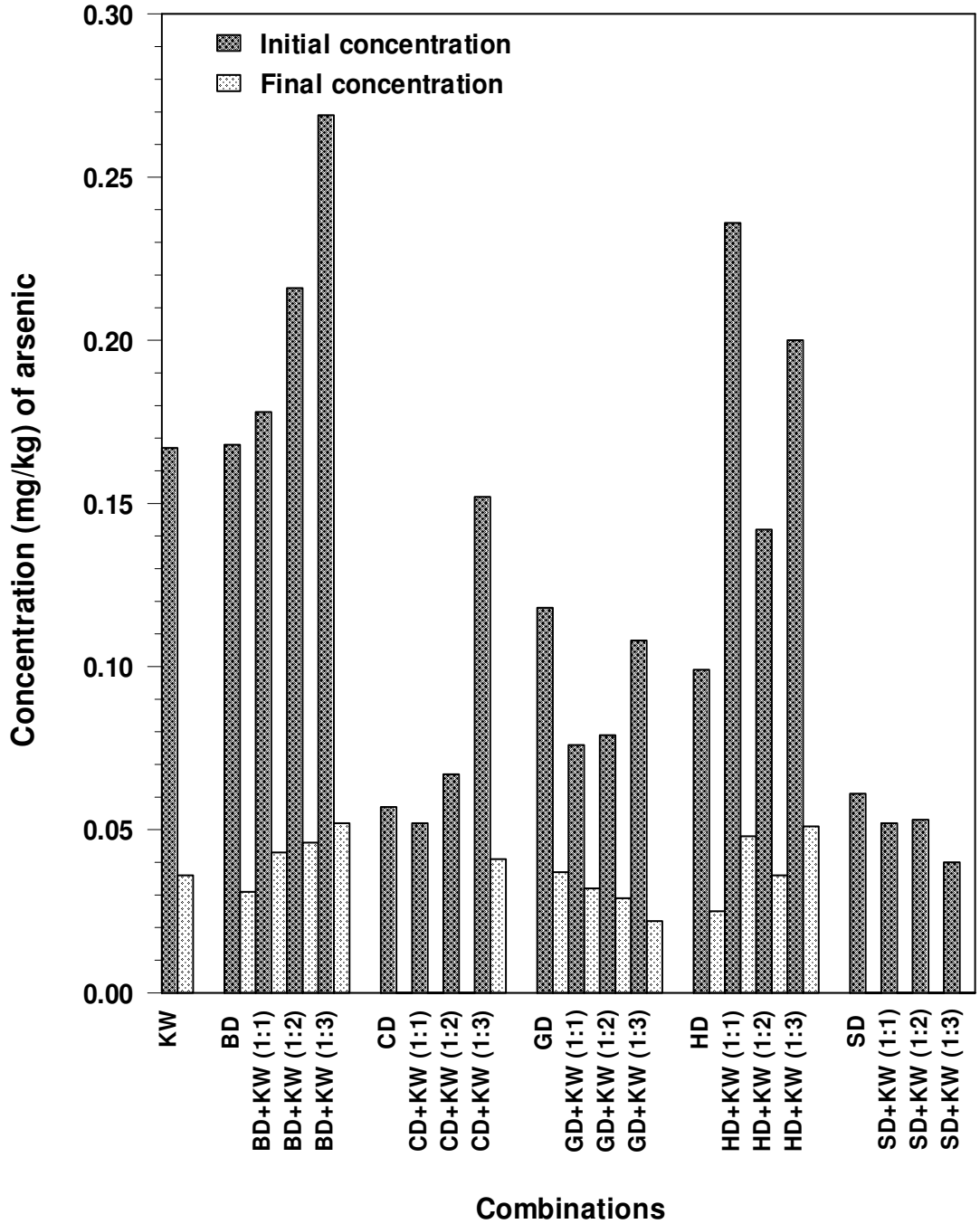



Figure 12. Concentration (mg/kg) of arsenic in different combinations of animal dung with kitchen wastes in initial feed mixture and final vermicompost.

# Section : II

# Heavy metals concentration in the earthworm (*Eisenia foetida*) body before and after vermicomposting

The data displayed in (Tables 14-19) and illustrated in (Figures 13-24) demonstrated the concentration of different heavy metals, namely, cobalt (Co), chromium (Cr), lead (Pb), nickel (Ni), cadmium (Cd) and arsenic (As) inside the body of *Eisenia foetida* before and after vermicomposting of different combinations of animal (buffalo, cow, goat, horse and sheep) dungs with municipal solid (MSW) wastes and kitchen waste (KW) and in the ratio of 1:1, 1:2 and 1:3. The results show, that the accumulation of heavy metals (Co, Cr, Pb, Ni, Cd and As) in the body tissue of *Eisenia foetida* significantly increased during vermic-activity after vermicomposting (60 days). It implies that the earthworm, *Eisenia foetida* accumulated significantly Co from the vermibed of animal dungs MSW and KW after vermicomposting media and thus making it less available to the crops and higher trophic level.

## 1. Cobalt (Co)

Table 14 and Figure 13 shows that the concentration of cobalt inside the tissues of *Eisenia foetida* was observed to be significantly increased after the vermicomposting of different combinations of

animal dungs with MSW. Maximum value of Co inside the body of *Eisenia foetida* was observed when it was inoculated in the vermibed containing buffalo dung with MSW in the ratio of 1:3 (2.42 %, 6.734 ± 0.002 to 6.901 ± 0.003 mg/kg) followed by sheep dung with MSW (1:1) (1.30 %, 6.734± 0.002 to 6.823 ± 0.002 mg/kg), MSW (0.99 %, 6.734 ± 0.002 to 6.801 ± 0.005 mg/kg) and goat dung with MSW (1:3)(0.85 %, 6.734 ± 0.002 to 6.792 ± 0.005) (Table 14). In other combinations of animal dungs and MSW, the percentage of increase in the Co level in the time of *Eisenia foetida* ranged between 0.09 % (in cow dung) to 0.71 % (in cow dung with MSW).

The concentration of Co accumulated inside the body tissue of *Eisenia foetida* significantly increased when put inside the vermibed consisted of different animal dungs with kitchen wastes (KW) in different ratios (1:1, 1:2 and 1:3) after vermicomposting. The presence of significantly higher level of Co inside the body of *Eisenia foetida* was observed when it was inoculated with buffalo dung with KW (2.42 %, 6.734 ± 0.004 to 6.901±0.003 mg/kg) followed by cow dung with KW (1.87 %, 6.734 ± 0.004 to 6.862 ± 0.002 mg/kg), goat dung with kitchen wastes (1.59 %, 6.734 ± 0.004 to 6.843±0.003 mg/kg), horse dung with kitchen wastes (0.78 %, 6.734 ± 0.004 to 6.787±0.002 mg/kg), and sheep dung with kitchen wastes (0.69 %, 6.734 ± 0.004 to 6.862±0.002 mg/kg) (Table 15 and Figure 14).

## 2. Chromiun (Cr)

Data displayed in (Table 14) demonstrated that the concentration of Cr inside the tissues of *Eisenia foetida* significantly increased after the vermicomposting of different combinations of animal dungs with MSW. The maximum concentration of Cr increased in the body of *Eisenia foetida* during vermicomposting was observed when the earthworms were kept in the vermibeds containing goat dung with MSW in the ratio 1:2 (0.69 %, 114.515± 0.006 to 115.316 ± 0.003 mg/kg), followed by horse dung with MSW in the ratio of 1:3 (0.68%, 114.515± 0.006 to 115.301 ± 0.006 mg/kg) and cow dung with MSW in the ratio of 1:1 (0.66 %, 114.515± 0.006 to 115.276 ± 0.004 mg/kg). In other combinations of animal dungs and MSW, the percentage of increase in the Cr level inside the body of earthworm *Eisenia foetida* ranged between 0.41 % (with buffalo dung with MSW) to 0.65 % (with goat dung). It implies that the earthworm, *Eisenia foetida* is effective in lowering down the Cr in the vermibed of animal dung with MSW tested during vermicomposting (Figure 15).

Similarly, the concentration of Cr accumulated inside the body tissue of *Eisenia foetida* significantly increased when put inside the vermibed consisted of different animal dungs with KW in different ratios of 1:1, 1:2 and 1:3 after vermicomposting. The presence of significantly higher level of Cr inside *Eisenia foetida* was observed in the combination of buffalo dung (0.58 %, 114.515 ± 0.006 to 115.187 ± 0.002

mg/kg) followed by horse dung with kitchen wastes in ratio of 1:3 (0.56 %, 114.515 ± 0.006 to 115.158 ± 0.004 mg/kg), goat dung with KW in ratio of 1:3 (1.59 %, 114.515 ± 0.006 to 115.124 ± 0.004 mg/kg), sheep dung with kitchen wastes in ratio of 1:3 (0.0.49 %, 114.515 ± 0.006 to 115.075 ± 0.006 mg/kg), and cow dung with kitchen wastes in te ratio of 1:3 (0.48 %, 114.515 ± 0.006 to 115.072 ± 0.003 mg/kg) (Table 15 and Figure 16).

## 3. Lead (Pb)

The concentration of Pb inside the tissues of *Eisenia foetida* was observed to be significantly increased after the vermicomposting of different combinations of animal dungs with MSW. Maximum value of Pb inside the body of *Eisenia foetida* was observed when it was inoculated in the vermibed containing buffalo dung with municipal solid waste in the ratio of 1:1 (14.25 %, 9.438 ± 0.005 to 11.007 ± 0.002 mg/kg) followed by goat dung with municipal solid waste 1:2 (14.23 %, 9.438 ± 0.005 to 11.004 ± 0.003mg/kg), MSW (8.03 %, 9.438 ± 0.005 to 10.265 ± 0.004 mg/kg) and sheep dung with municipal solid waste 1:2 (7.89%, 9.438 ± 0.005 to 10.247 ± 0.005 mg/kg). In other combinations of animal dungs and MSW, the percentage of increase Pb level in the earthworm body in vermicomposts ranged between 0.0 % (in goat dung) to 6.67% (in buffalo dung) (Table 16 and Figure 17).

The data displayed in (Table 17 and Figure 18) demonstrated that the concentration of Pb accumulated inside the body tissue of *Eisenia foetida* significantly increased when put inside the vermibed consisted of different animal dungs with KW in different ratios of 1:1, 1:2 and 1:3 after vermicomposting. The presence of significantly higher level of Pb inside *Eisenia foetida* was observed in the combination of sheep dung with kitchen waste in the ratio of 1:3 (6.20 %, 9.438 ± 0.005 to 10.062 ± 0.003 mg/kg) followed by horse dung with kitchen wastes in the ratio of 1:3 (6.04 %, 9.438 ± 0.005 to 6.862 ± 0.002 mg/kg), buffalo dung with kitchen wastes in the ratio of 1:3 (5.99 %, 9.438 ± 0.005 to 10.039 ± 0.004 mg/kg), sheep dung with kitchen wastes in the ratio of 1:2 (5.04 %, 9.438 ± 0.005 to 9.939 ± 0.002 mg/kg), and goat dung with kitchen wastes in the ratio of 1:3 (4.50 %, 9.438 ± 0.005 to 9.883 ± 0.004 mg/kg). In other combinations of animal dung and kitchen waste, the percentage of increase in the Pb level in earthworm body during prepared vermicomposts ranged between 0.14 % in horse dung to 4.41% in sheep dung with kitchen waste.

## 4. Nickel (Ni)

Data displayed in (Table 16) demonstrated that the concentration of Ni inside the body of earthworm *Eisenia foetida* was observed to be significantly increased after the vermicomposting of different combinations of animal dungs with municipal solid waste (MSW). The significantly higher value of Ni in *Eisenia foetida* was observed when

the earthworm was kept in the vermibed containing goat dung (11.75 %, 6.339 ± 0.002 to 7.183 ± 0.002 mg/kg) followed by sheep dung (2.64 %, 6.339 ± 0.002 to 6.511 ± 0.004 kg/kg), cow dung with MSW in the ration of 1:3 (1.98 %, 6.339 ± 0.002 to 6.467 ± 0.004 mg/kg) and buffalo dung (1.95 %, 6.339 ± 0.002 to 6.465 ± 0.005 mg/kg). In other combinations of animal dungs and MSW, the percentage of increase in the Ni level accumulates in their body of earthworm during preparation of vermicomposts ranged between 0.98 % (in MSW) to 1.92 % (in cow dung with MSW) (Figure 19).

The concentration of nickel accumulated inside the body tissue of *Eisenia foetida* significantly increased when put inside the vermibed consisted of different animal dungs with kitchen wastes in different rations (1:1, 1:2 and 1:3) after vermicomposting. The presence of significantly higher level of Ni was observed in the combination of buffalo dung with kitchen waste in the ratio of (1:1) (11.04 %, 6.339 ± 0.002 to 7.126 ± 0.004 mg/kg) followed by horse dung with kitchen wastes in the ratio of (1:3) (3.10 %, 6.339 ± 0.002 to 6.542 ± 0.004 mg/kg), cow dung with kitchen wastes in the ratio of (1:3) (2.30 %, 6.339 ± 0.002 to 6.488 ± 0.003 mg/kg), kitchen wastes (1.66 %, 6.339 ± 0.002 to 6.446 ± 0.003 mg/kg), sheep dung with kitchen wastes in the ratio of (1:3) (1.60 %, 6.339 ± 0.002 to 6.488 ± 0.003 mg/kg). In other combinations of animal dung and kitchen waste, the percentage of

decrease in the Ni level in the vermicomposts ranged between -0.24 % in cow dung to 1.38 % in goat dung (Table 17 and Figure 20).

## 5. Cadmium (Cd)

The concentration of cadmium inside the tissues of *Eisenia foetida* was observed to be significantly increased in after the vermicomposting of different combinations of animal dungs with municipal solid waste (MSW) in the ratio of 1:1, 1:2 and 1:3. The significantly higher value of cadmium inside *Eisenia foetida* was observed when the earthworm was kept in the vermibed containing cow dung with municipal solid waste in the ration of 1:2 (1.12 %, 61.645 ± 0.004 to 62.346 ±0.004 mg/kg) followed by horse dung (0.83 %, 61.645 ± 0.004 to 62.161 ± 0.003 kg/kg), goat dung with municipal solid waste in the ration of 1:1 (0.45 %, 61.645 ± 0.004 to 61.926 ± 0.003 mg/kg), horse dung with municipal solid waste in the ratio of 1:2 (0.42 %, 61.645 ± 0.004 to 61.904 ± 0.003 mg/kg) and buffalo dung (0.34 %, 61.645 ± 0.004 to 61.854 ± 0.003 mg/ kg). In other combinations of animal dung and MSW, the percentage of increase in the Cd concentration in the vermicomposts ranged between 0.06 % in buffalo dung with MSW to 0.31 % in sheep dung with MSW (Table 18 and Figure 21).

Similarly, the concentration of Cd accumulated inside the body tissue of *Eisenia foetida* significantly increased when put inside the vermibed consisted of different animal dungs with kitchen wastes in different ratios 1:1, 1:2 and 1:3 after vermicomposting. The presence of

significantly higher level of Ni was observed in the combination of horse dung 1:1 (0.48 %, 61.645 ± 0.004 to 61.945 ± 0.003 mg/kg) followed by goat dung (0.40 %, 61.645 ± 0.004 to 61.894 ± 0.004 mg/kg), sheep dung (0.36 %, 61.645 ± 0.004 to 61.868 ± 0.003 mg/kg), buffalo dung with kitchen wastes in the ratio of 1:3 (0.34 %, 61.645 ± 0.004 to 61.857 ± 0.005 mg/kg), sheep dung with kitchen wastes in the ratio of 1:3 (0.34 %, 61.645 ± 0.004 to 61.853 ± 0.002 mg/kg). In other combinations of animal dung and kitchen waste, the percentage of increase in the Cd level in the vermicomposts ranged between 0.09 % in horse dung with kitchen waste to 0.33 % in buffalo dung (Table 19 and Figure 22).

## 6. Arsenic (As)

Data displayed in (Table 18 and Figure 23) demonstrated that The concentration of arsenic accumulate in the body of earthworm *Eisenia foetida* was observed to be significantly increased in after the vermicomposting of different combinations of animal dungs with municipal solid waste (MSW). The significantly higher value of As inside the *Eisenia foetida* was observed when the earthworm was kept in the vermibed containing buffalo dung with municipal solid waste in the ration of 1:3 (1.58 %, 9.450 ± 0.003 to 9.602 ± 0.005 mg/kg) followed by buffalo dung (1.46 %, 9.450 ± 0.003 to 9.590 ± 0.003 kg/kg), horse dung with municipal solid waste in the ration of 1:1 (0.90 %, 9.450 ± 0.003 to 9.536 ± 0.007 mg/kg). In other combinations of animal dung

and MSW, the percentage of increase in the arsenic level in the vermicomposts ranged between 0.04 % (in cow dung with MSW) to 0.85 % (in goat dung).

There was significantly increased concentration of arsenic obtain in the body of earthworm *Eisenia foetida* inoculated in the combination of animal dung with kitchen waste in different ratio 1:1, 1:2 and 1:3 after vermicomposting. The presence of significantly higher level of arsenic was observed in the combination of buffalo dung with kitchen wastes in the ratio of 1:3 (2.05%, 9.450 ± 0.003 to 9.648 ± 0.002 mg/kg) followed by horse dung with kitchen wastes in the ratio of 1:3 (1.63 %, 9.450 ± 0.003 to 9.607 ± 0.002 mg/kg) and also observed in the cow dung with kitchen wastes in the ratio of 1:3 (0.96%, 9.450 ± 0.003 to 9.542 ± 0.004 mg/kg). In other combinations of animal dungs and KW, the percentage of increase in the As level in the vermicomposts ranged between 0.86 % in goat dung to 0.33 % in buffalo dung (Table 19 and Figure 24).

Among all the combinations of animal dung with municipal solid and kitchen wastes, the cobalt (Co) and arsenic (As) were significantly increased in the earthworm *Eisenia foetida* body when inoculated with the combination of buffalo dung with municipal solid waste in the ratio of 1:3, while the lead (Pb) was observed to increase significantly in the earthworm body when inoculated with the combination of goat dung with municipal solid waste in the ratio of 1:2. Similarly, the chromium

(Cr), nickel (Ni) and cadmium (Cd) were also observed to increase in earthworm body after vermicomposting with the combination of buffalo dung, goat dung and cow dung with municipal solid waste in the ratio of 1:2. The results showed that the earthworm *Eisenia foetida* was a suitable species for accumulation of heavy metals from different animal dungs with municipal solid wastes in different ratios (1:1, 1:2 and 1:3).

Table 14: Concentration of cobalt and chromium (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with municipal solid wastes.

| **Particulars** | **Ratio** | **Cobalt** | **% increase** | **Chromium** | **% increase** |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 6.734 ± 0.004 | - | 114.515± 0.006 | - |
| MSW+Ef | - | 6.801 ± 0.005* | 0.99 | 115.252 ± 0.003* | 0.64 |
| Buffalo dung+ Ef | - | 6.753 ± 0.003* | 0.28 | 115.017 ± 0.002* | 0.44 |
| Buffalo dung+MSW+ Ef | 1:1 | 6.812 ± 0.005* | 1.15 | 115.081 ± 0.005* | 0.49 |
| Buffalo dung+MSW+ Ef | 1:2 | 6.884 ± 0.002* | 2.18 | 115.108 ± 0.002* | 0.52 |
| Buffalo dung+MSW+ Ef | 1:3 | 6.901 ± 0.003* | 2.42 | 114.991 ± 0.005* | 0.41 |
| Cow dung+ Ef | - | 6.734 ± 0.003 | 0.00 | 115.255 ± 0.006* | 0.64 |
| Cow dung+MSW+ Ef | 1:1 | 6.740 ± 0.003* | 0.09 | 115.276 ± 0.004* | 0.66 |
| Cow dung+MSW+ Ef | 1:2 | 6.782 ± 0.004* | 0.71 | 115.098 ± 0.002* | 0.51 |
| Cow dung+MSW+ Ef | 1:3 | 6.779 ± 0.005* | 0.66 | 115.124 ± 0.004* | 0.53 |
| Goat dung+ Ef | | 6.734 ± 0.002 | 0.00 | 115.262 ± 0.003* | 0.65 |
| Goat dung+MSW+ Ef | 1:1 | 6.743 ± 0.003* | 0.00 | 115.203 ± 0.004* | 0.60 |
| Goat dung+MSW+ Ef | 1:2 | 6.776 ± 0.002* | 0.62 | 115.316 ± 0.003* | 0.69 |
| Goat dung+MSW+ Ef | 1:3 | 6.792 ± 0.005* | 0.85 | 115.202 ± 0.003* | 0.60 |
| Horse dung+ Ef | | 6.740 ± 0.003* | 0.09 | 115.119 ± 0.002* | 0.52 |
| Horse dung+MSW+ Ef | 1:1 | 6.751 ± 0.003* | 0.25 | 115.257 ± 0.006* | 0.64 |
| Horse dung+MSW+ Ef | 1:2 | 6.765 ± 0.003* | 0.46 | 115.220 ± 0.004* | 0.61 |
| Horse dung+MSW+ Ef | 1:3 | 6.772 ± 0.004* | 0.56 | 115.301 ± 0.006* | 0.68 |
| Sheep dung+ Ef | | 6.761 ± 0.004* | 0.40 | 115.224 ± 0.004* | 0.62 |
| Sheep dung+ MSW+ Ef | 1:1 | 6.823 ± 0.006* | 1.30 | 115.237 ± 0.004* | 0.63 |
| Sheep dung+MSW+ Ef | 1:2 | 6.765 ± 0.007* | 0.46 | 115.211 ± 0.007* | 0.60 |
| Sheep dung+MSW+ Ef | 1:3 | 6.753 ± 0.003* | 0.28 | 115.216 ± 0.003* | 0.61 |

MSW = Municipal Solid Wastes, Ef = inoculation with *Eisenia foetida,*
Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

Table 15: Concentration of cobalt and chromium (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with kitchen wastes.

| **Particulars** | **Ratio** | **Cobalt** | **% increase** | **Chromium** | **% increase** |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 6.734 ± 0.004 | - | 114.515 ± 0.006 | - |
| KW+Ef | - | 6.758 ± 0.002* | 0.36 | 115.031 ± 0.004* | 0.45 |
| Buffalo dung+Ef | - | 6.749 ± 0.003* | 0.22 | 115.187 ± 0.002* | 0.58 |
| Buffalo dung + KW+Ef | 1:1 | 6.746 ± 0.006* | 0.18 | 115.024 ± 0.003* | 0.44 |
| Buffalo dung + KW+Ef | 1:2 | 6.775 ± 0.004* | 0.61 | 115.017 ± 0.002* | 0.44 |
| Buffalo dung + KW+Ef | 1:3 | 6.901 ± 0.003* | 2.42 | 114.981 ± 0.004* | 0.41 |
| Cow dung+Ef | - | 6.734 ± 0.003 | 0.00 | 114.905 ± 0.006* | 0.34 |
| Cow dung + KW+Ef | 1:1 | 6.734 ± 0.002 | 0.00 | 115.005 ± 0.005* | 0.43 |
| Cow dung + KW+Ef | 1:2 | 6.734 ± 0.004 | 0.00 | 115.021 ± 0.003* | 0.44 |
| Cow dung + KW+Ef | 1:3 | 6.781 ± 0.003* | 0.69 | 115.072 ± 0.003* | 0.48 |
| Goat dung+Ef | - | 6.745 ± 0.003* | 0.16 | 114.837 ± 0.003* | 0.28 |
| Goat dung + KW+Ef | 1:1 | 6.748 ± 0.004* | 0.21 | 114.724 ± 0.004* | 0.18 |
| Goat dung + KW+Ef | 1:2 | 6.770 ± 0.003* | 0.53 | 114.919 ± 0.003* | 0.35 |
| Goat dung + KW+Ef | 1:3 | 6.843 ± 0.003* | 1.59 | 115.124 ± 0.004* | 0.53 |
| Horse dung+Ef | - | 6.747 ± 0.003* | 0.19 | 115.021 ± 0.002* | 0.44 |
| Horse dung + KW+Ef | 1:1 | 6.745 ± 0.005* | 0.16 | 115.005 ± 0.003* | 0.43 |
| Horse dung + KW+Ef | 1:2 | 6.763 ± 0.004* | 0.43 | 115.137 ± 0.003* | 0.54 |
| Horse dung + KW+Ef | 1:3 | 6.787 ± 0.002* | 0.78 | 115.158 ± 0.004* | 0.56 |
| Sheep dung+Ef | - | 6.771 ± 0.004* | 0.55 | 115.001 ± 0.004* | 0.42 |
| Sheep dung + KW+Ef | 1:1 | 6.778 ± 0.003* | 0.65 | 114.975 ± 0.003* | 0.40 |
| Sheep dung + KW+Ef | 1:2 | 6.824 ± 0.004* | 1.32 | 114.993 ± 0.002* | 0.42 |
| Sheep dung + KW+Ef | 1:3 | 6.862 ± 0.002* | 1.87 | 115.075 ± 0.006* | 0.49 |

KW = Kitchen wastes, Ef = inoculation with *Eisenia foetida,*
Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

Table 16: Concentration of lead and nickel (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with municipal solid wastes.

| **Particulars** | **Ratio** | **Lead** | **% increase** | **Nickel** | **% increase** |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 9.438 ± 0.005 | - | 6.339 ± 0.002 | - |
| MSW+Ef | - | 10.265 ± 0.004* | 8.06 | 6.402 ± 0.004* | 0.98 |
| Buffalo dung+ Ef | - | 10.112 ± 0.003* | 6.67 | 6.465 ± 0.005* | 1.95 |
| Buffalo dung+MSW+ Ef | 1:1 | 11.007 ± 0.002* | 14.25 | 6.439 ± 0.003* | 1.55 |
| Buffalo dung+MSW+ Ef | 1:2 | 9.501 ± 0.004* | 0.66 | 6.432 ± 0.005* | 1.45 |
| Buffalo dung+MSW+ Ef | 1:3 | 9.438 ± 0.003* | 0.00 | 6.448 ± 0.005* | 1.69 |
| Cow dung+ Ef | - | 9.448 ± 0.003* | 0.11 | 6.444 ± 0.004* | 1.63 |
| Cow dung+MSW+ Ef | 1:1 | 9.451 ± 0.004* | 0.14 | 6.431 ± 0.002* | 1.43 |
| Cow dung+MSW+ Ef | 1:2 | 9.469 ± 0.002* | 0.33 | 6.463 ± 0.003* | 1.92 |
| Cow dung+MSW+ Ef | 1:3 | 9.498 ± 0.007* | 0.63 | 6.467 ± 0.004* | 1.98 |
| Goat dung+ Ef | - | 9.438 ± 0.002* | 0.00 | 7.183 ± 0.002* | 11.75 |
| Goat dung+MSW+ Ef | 1:1 | 9.501 ± 0.006* | 0.66 | 6.454 ± 0.005* | 1.78 |
| Goat dung+MSW+ Ef | 1:2 | 11.004 ± 0.003* | 14.23 | 6.456 ± 0.003* | 1.81 |
| Goat dung+MSW+ Ef | 1:3 | 9.523 ± 0.004* | 0.89 | 6.429 ± 0.005* | 1.40 |
| Horse dung+ Ef | - | 9.561 ± 0.004* | 1.29 | 6.443 ± 0.004* | 1.61 |
| Horse dung+MSW+ Ef | 1:1 | 9.501 ± 0.007* | 0.66 | 6.416 ± 0.003* | 1.20 |
| Horse dung+MSW+ Ef | 1:2 | 9.461 ± 0.006* | 0.24 | 6.434 ± 0.003* | 1.48 |
| Horse dung+MSW+ Ef | 1:3 | 9.452 ± 0.003* | 0.15 | 6.431 ± 0.003* | 1.43 |
| Sheep dung+ Ef | - | 10.103 ± 0.003* | 6.58 | 6.511 ± 0.004* | 2.64 |
| Sheep dung+ MSW+ Ef | 1:1 | 9.936 ± 0.007* | 5.01 | 6.447 ± 0.006* | 1.68 |
| Sheep dung+MSW+ Ef | 1:2 | 10.247 ± 0.005* | 7.89 | 6.440 ± 0.002* | 1.57 |
| Sheep dung+MSW+ Ef | 1:3 | 10.168 ± 0.003* | 7.18 | 6.425 ± 0.003* | 1.34 |

MSW = Municipal Solid Wastes, Ef = inoculation with *Eisenia foetida*,

Values are expressed as Mean ± SD (six replicates).

*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

Table 17: Concentration of lead and nickel (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with kitchen wastes.

| **Particulars** | **Ratio** | **Lead** | **% increase** | **Nickel** | **% increase** |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 9.438 ± 0.005 | - | 6.339 ± 0.002 | - |
| KW+Ef | - | 9.562 ± 0.002* | 1.30 | 6.446 ± 0.003* | 1.66 |
| Buffalo dung+Ef | - | 9.940 ± 0.003* | 5.05 | 7.004 ± 0.005* | 9.49 |
| Buffalo dung + KW+Ef | 1:1 | 9.733 ± 0.006* | 3.03 | 7.126 ± 0.004* | 11.04 |
| Buffalo dung + KW+Ef | 1:2 | 9.842 ± 0.005* | 4.10 | 7.104 ± 0.003* | 10.77 |
| Buffalo dung + KW+Ef | 1:3 | 10.039 ± 0.004* | 5.99 | 6.848 ± 0.003* | 7.43 |
| Cow dung+Ef | - | 9.531 ± 0.003* | 0.98 | 6.324 ± 0.003* | -0.24 |
| Cow dung + KW+Ef | 1:1 | 9.518 ± 0.004* | 0.84 | 6.338 ± 0.006* | -0.02 |
| Cow dung + KW+Ef | 1:2 | 9.553 ± 0.005* | 1.20 | 6.414 ± 0.003* | 1.17 |
| Cow dung + KW+Ef | 1:3 | 9.649 ± 0.003* | 2.19 | 6.488 ± 0.003* | 2.30 |
| Goat dung+Ef | - | 9.508 ± 0.006* | 0.74 | 6.428 ± 0.004* | 1.38 |
| Goat dung + KW+Ef | 1:1 | 9.536 ± 0.005* | 1.03 | 6.391 ± 0.002* | 0.81 |
| Goat dung + KW+Ef | 1:2 | 9.644 ± 0.004* | 2.14 | 6.394 ± 0.008* | 0.86 |
| Goat dung + KW+Ef | 1:3 | 9.883 ± 0.004* | 4.50 | 6.397 ± 0.004* | 0.91 |
| Horse dung+Ef | - | 9.451 ± 0.004* | 0.14 | 6.397 ± 0.002* | 0.91 |
| Horse dung + KW+Ef | 1:1 | 9.493 ± 0.003* | 0.58 | 6.401 ± 0.006* | 0.97 |
| Horse dung + KW+Ef | 1:2 | 9.592 ± 0.004* | 1.61 | 6.428 ± 0.003* | 1.38 |
| Horse dung + KW+Ef | 1:3 | 10.045 ± 0.002* | 6.04 | 6.542 ± 0.004* | 3.10 |
| Sheep dung+Ef | - | 9.886 ± 0.003* | 4.53 | 6.426 ± 0.004* | 1.35 |
| Sheep dung + KW+Ef | 1:1 | 9.873 ± 0.004* | 4.41 | 6.391 ± 0.002* | 0.81 |
| Sheep dung + KW+Ef | 1:2 | 9.939 ± 0.002* | 5.04 | 6.409 ± 0.007* | 1.09 |
| Sheep dung + KW+Ef | 1:3 | 10.062 ± 0.003* | 6.20 | 6.442 ± 0.007* | 1.60 |

KW = Kitchen wastes, Ef = inoculation with *Eisenia foetida,*

Values are expressed as Mean ± SD (six replicates).

*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

Table 18: Concentration of cadmium and arsenic (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with municipal solid wastes.

| **Particulars** | **Ratio** | **Cadmium** | **% increase** | **Arsenic** | **% increase** |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 61.645 ± 0.004 | - | 9.450 ± 0.003 | - |
| MSW+Ef | - | 61.802 ± 0.006* | 0.25 | 9.471 ± 0.003* | 0.22 |
| Buffalo dung+ Ef | - | 61.854 ± 0.003* | 0.34 | 9.590 ± 0.003* | 1.46 |
| Buffalo dung+MSW+ Ef | 1:1 | 61.712 ± 0.002* | 0.11 | 9.552 ± 0.002* | 1.07 |
| Buffalo dung+MSW+ Ef | 1:2 | 61.683 ± 0.003* | 0.06 | 9.560 ± 0.003* | 1.15 |
| Buffalo dung+MSW+ Ef | 1:3 | 61.680 ± 0.003* | 0.06 | 9.602 ± 0.005* | 1.58 |
| Cow dung+ Ef | - | 61.741 ± 0.004* | 0.16 | 9.471 ± 0.003* | 0.22 |
| Cow dung+MSW+ Ef | 1:1 | 61.715 ± 0.003* | 0.11 | 9.454 ± 0.007* | 0.04 |
| Cow dung+MSW+ Ef | 1:2 | 62.346 ±0.004* | 1.12 | 9.460 ± 0.003* | 0.11 |
| Cow dung+MSW+ Ef | 1:3 | 61.719 ± 0.005* | 0.12 | 9.503 ± 0.004* | 0.56 |
| Goat dung+ Ef | - | 61.814 ± 0.004* | 0.27 | 9.531 ± 0.002* | 0.85 |
| Goat dung+MSW+ Ef | 1:1 | 61.926 ± 0.003* | 0.45 | 9.507 ± 0.005* | 0.60 |
| Goat dung+MSW+ Ef | 1:2 | 61.703 ± 0.002* | 0.09 | 9.465 ± 0.005* | 0.16 |
| Goat dung+MSW+ Ef | 1:3 | 61.734 ± 0.005* | 0.14 | 9.457 ± 0.003* | 0.07 |
| Horse dung+ Ef | - | 62.161 ± 0.003* | 0.83 | 9.474 ± 0.003* | 0.25 |
| Horse dung+MSW+ Ef | 1:1 | 61.829 ± 0.002* | 0.30 | 9.536 ± 0.007* | 0.90 |
| Horse dung+MSW+ Ef | 1:2 | 61.904 ± 0.003* | 0.42 | 9.527 ± 0.005* | 0.81 |
| Horse dung+MSW+ Ef | 1:3 | 61.821 ± 0.004* | 0.28 | 9.509 ± 0.004* | 0.62 |
| Sheep dung+ Ef | - | 61.807 ± 0.003* | 0.26 | 9.478 ± 0.003* | 0.30 |
| Sheep dung+ MSW+ Ef | 1:1 | 61.821 ± 0.004* | 0.28 | 9.472 ± 0.003* | 0.23 |
| Sheep dung+MSW+ Ef | 1:2 | 61.811 ± 0.005* | 0.27 | 9.467 ± 0.003* | 0.18 |
| Sheep dung+MSW+ Ef | 1:3 | 61.834 ± 0.002* | 0.31 | 9.486 ± 0.007* | 0.38 |

MSW = Municipal Solid Wastes, Ef = inoculation with *Eisenia foetida,*

Values are expressed as Mean ± SD (six replicates).

*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

Table 19: Concentration of cadmium and arsenic (mg/kg) in earthworm body before inoculation in vermibeds and after final vermicomposting of different combinations of animal dung with kitchen wastes.

| Particulars | Ratio | Cadmium | % increase | Arsenic | % increase |
|---|---|---|---|---|---|
| Earthworm body (control) before inoculation | | 61.645 ± 0.004 | - | 9.450 ± 0.003 | - |
| KW+Ef | - | 61.703 ± 0.003* | 0.09 | 9.512 ± 0.004* | 0.65 |
| Buffalo dung+Ef | - | 61.851 ± 0.003* | 0.33 | 9.578 ± 0.003* | 1.34 |
| Buffalo dung + KW+Ef | 1:1 | 61.835 ± 0.003* | 0.31 | 9.571 ± 0.004* | 1.26 |
| Buffalo dung + KW+Ef | 1:2 | 61.831 ± 0.005* | 0.30 | 9.616 ± 0.003* | 1.73 |
| Buffalo dung + KW+Ef | 1:3 | 61.857 ± 0.005* | 0.34 | 9.648 ± 0.002* | 2.05 |
| Cow dung+Ef | - | 61.756 ± 0.004* | 0.18 | 9.485 ± 0.003* | 0.37 |
| Cow dung + KW+Ef | 1:1 | 61.741 ± 0.002* | 0.16 | 9.482 ± 0.005* | 0.34 |
| Cow dung + KW+Ef | 1:2 | 61.762 ± 0.001* | 0.19 | 9.503 ± 0.005* | 0.56 |
| Cow dung + KW+Ef | 1:3 | 61.791 ± 0.003* | 0.24 | 9.542 ± 0.004* | 0.96 |
| Goat dung+Ef | - | 61.894 ± 0.004* | 0.40 | 9.532 ± 0.002* | 0.86 |
| Goat dung + KW+Ef | 1:1 | 61.709 ± 0.006* | 0.10 | 9.486 ± 0.003* | 0.38 |
| Goat dung + KW+Ef | 1:2 | 61.753 ± 0.003* | 0.17 | 9.492 ± 0.002* | 0.44 |
| Goat dung + KW+Ef | 1:3 | 61.812 ± 0.003* | 0.27 | 9.525 ± 0.007* | 0.79 |
| Horse dung+Ef | - | 61.945 ± 0.003* | 0.48 | 9.504 ± 0.003* | 0.57 |
| Horse dung + KW+Ef | 1:1 | 61.762 ± 0.006* | 0.19 | 9.548 ± 0.007* | 1.03 |
| Horse dung + KW+Ef | 1:2 | 61.793 ± 0.005* | 0.24 | 9.592 ± 0.005* | 1.48 |
| Horse dung + KW+Ef | 1:3 | 61.698 ± 0.007* | 0.09 | 9.607 ± 0.002* | 1.63 |
| Sheep dung+Ef | - | 61.868 ± 0.003* | 0.36 | 9.491 ± 0.003* | 0.43 |
| Sheep dung + KW+Ef | 1:1 | 61.751 ± 0.004* | 0.17 | 9.485 ± 0.005* | 0.37 |
| Sheep dung + KW+Ef | 1:2 | 61.768 ± 0.003* | 0.20 | 9.488 ± 0.004* | 0.40 |
| Sheep dung + KW+Ef | 1:3 | 61.853 ± 0.002* | 0.34 | 9.475 ± 0.004* | 0.26 |

KW = Kitchen wastes, Ef = inoculation with *Eisenia foetida,*

Values are expressed as Mean ± SD (six replicates).

*Differences between mean values of concentration of heavy metals inside earthworm body before inoculation in vermibeds and after vermicomposting are significant at $P<0.05$ (t-test).

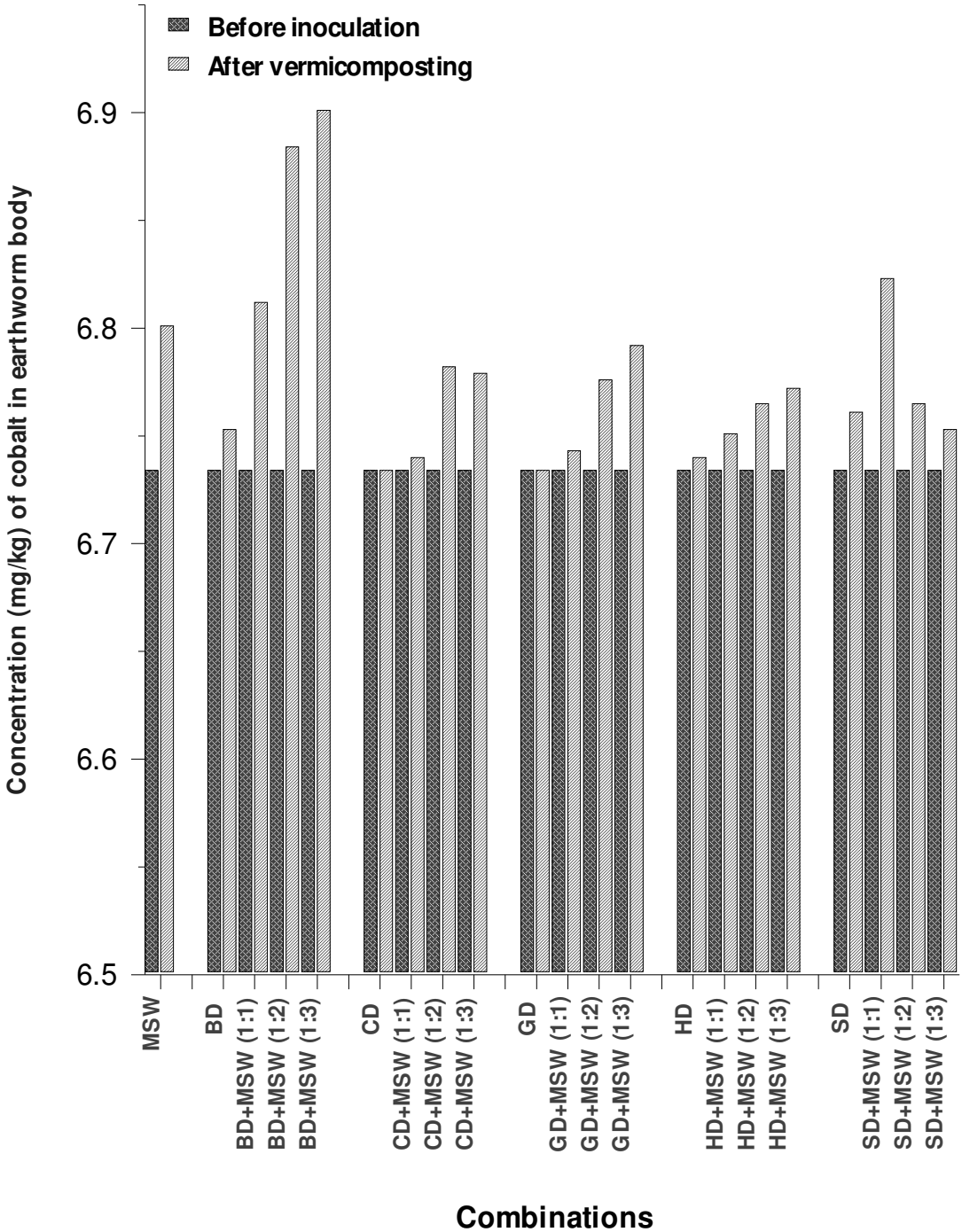



Figure 13. Concentration of cobalt (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

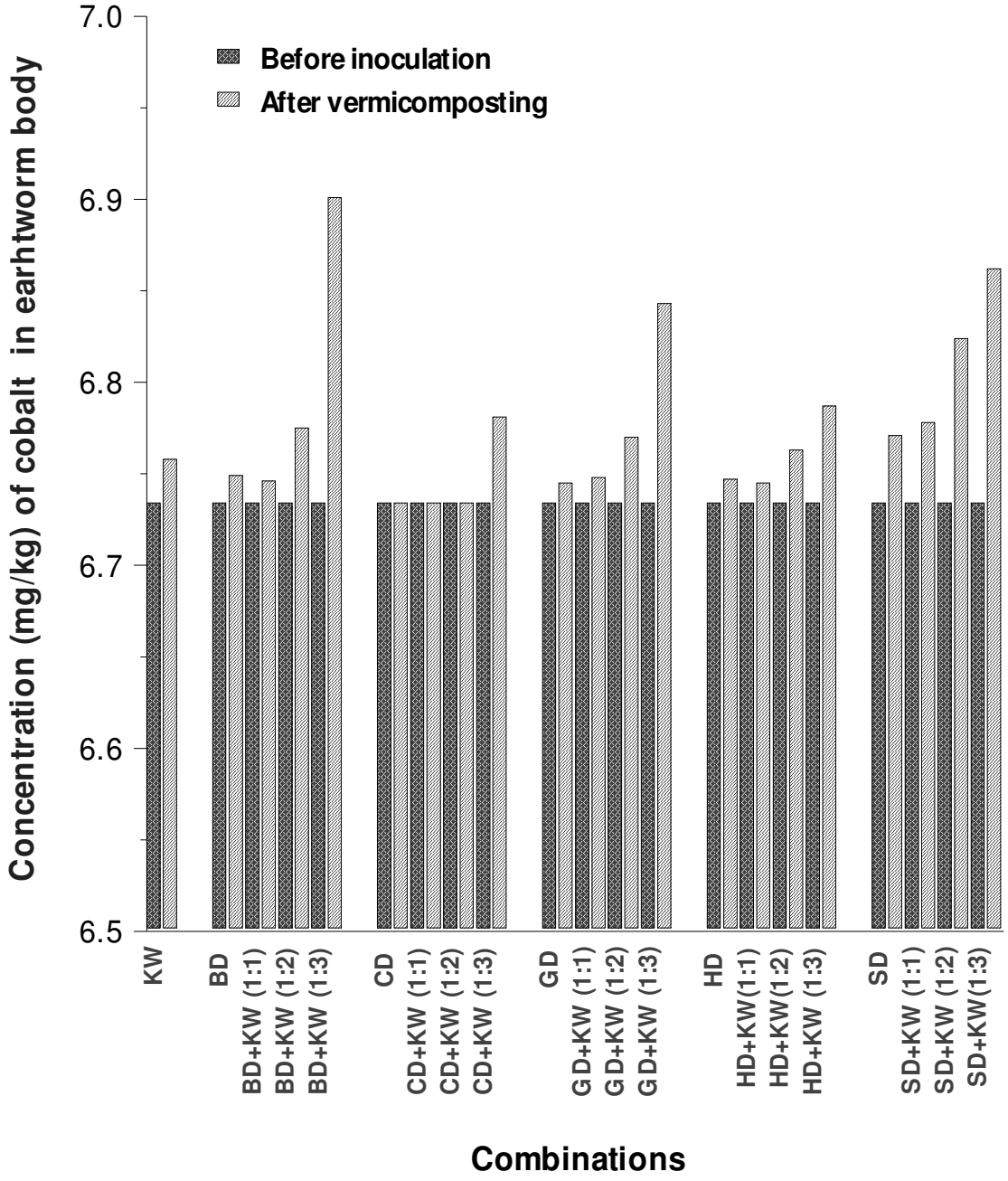



Figure 14. Concentration of cobalt (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

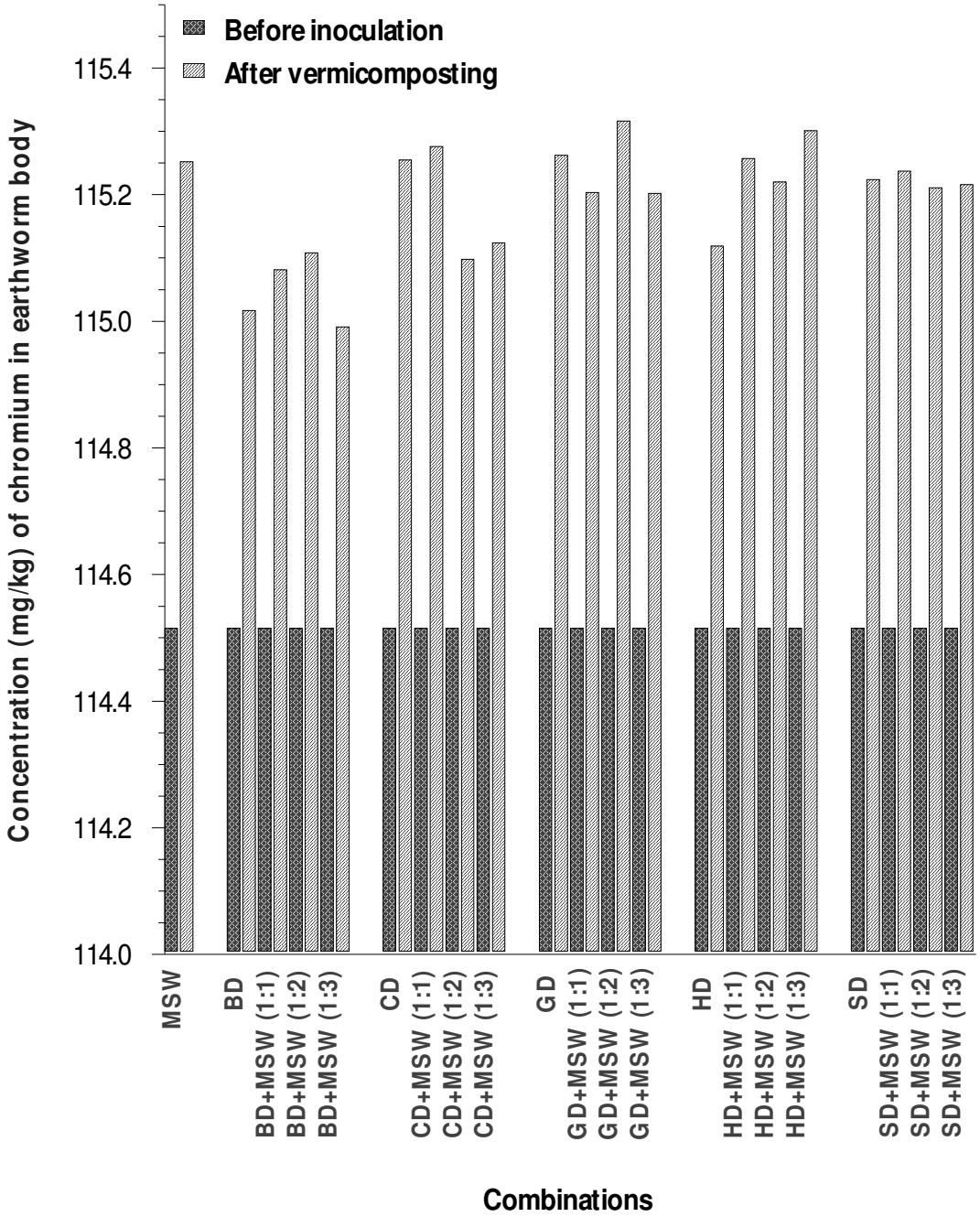



Figure 15. Concentration of chromium (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

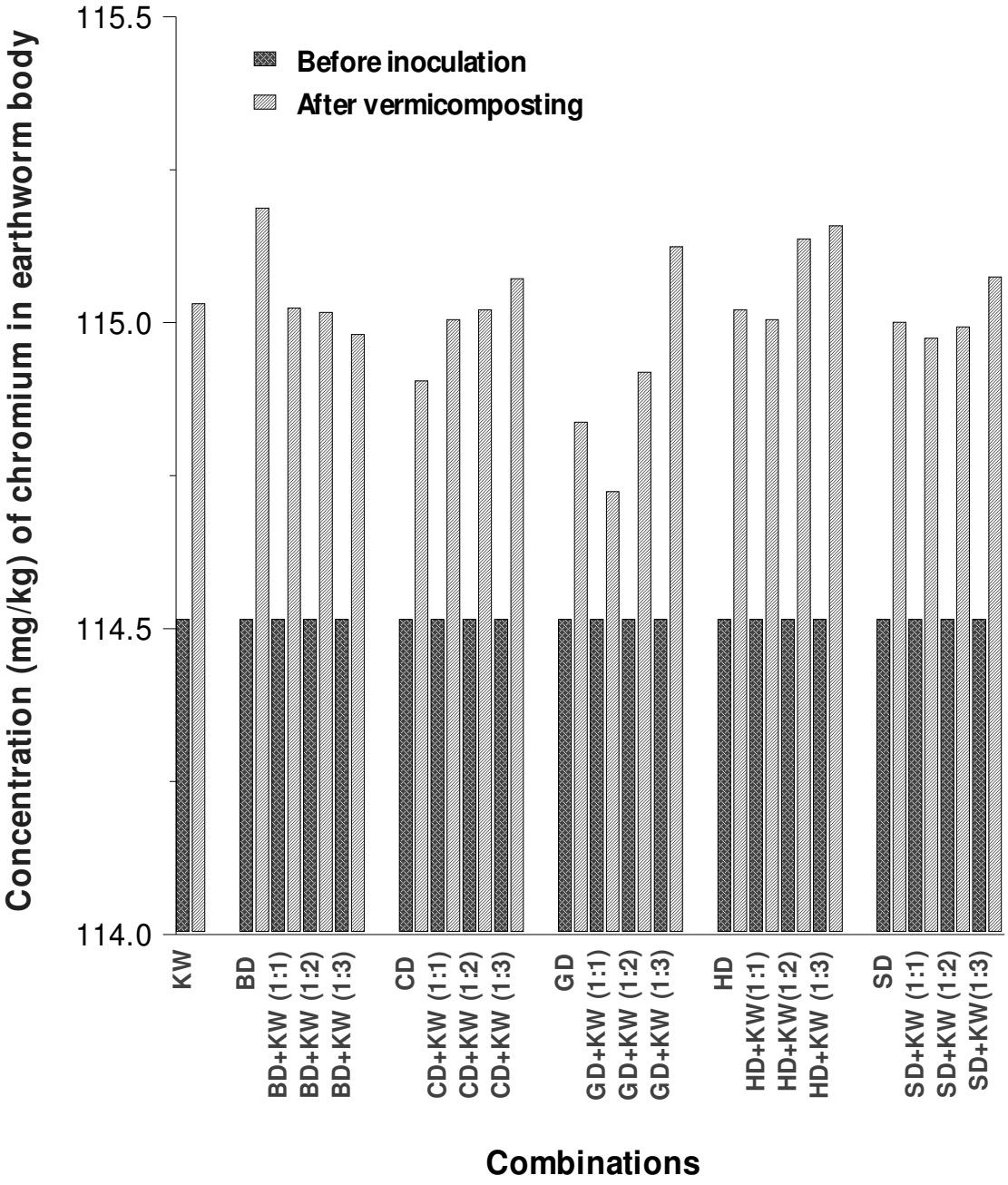



Figure 16. Concentration of chromium (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

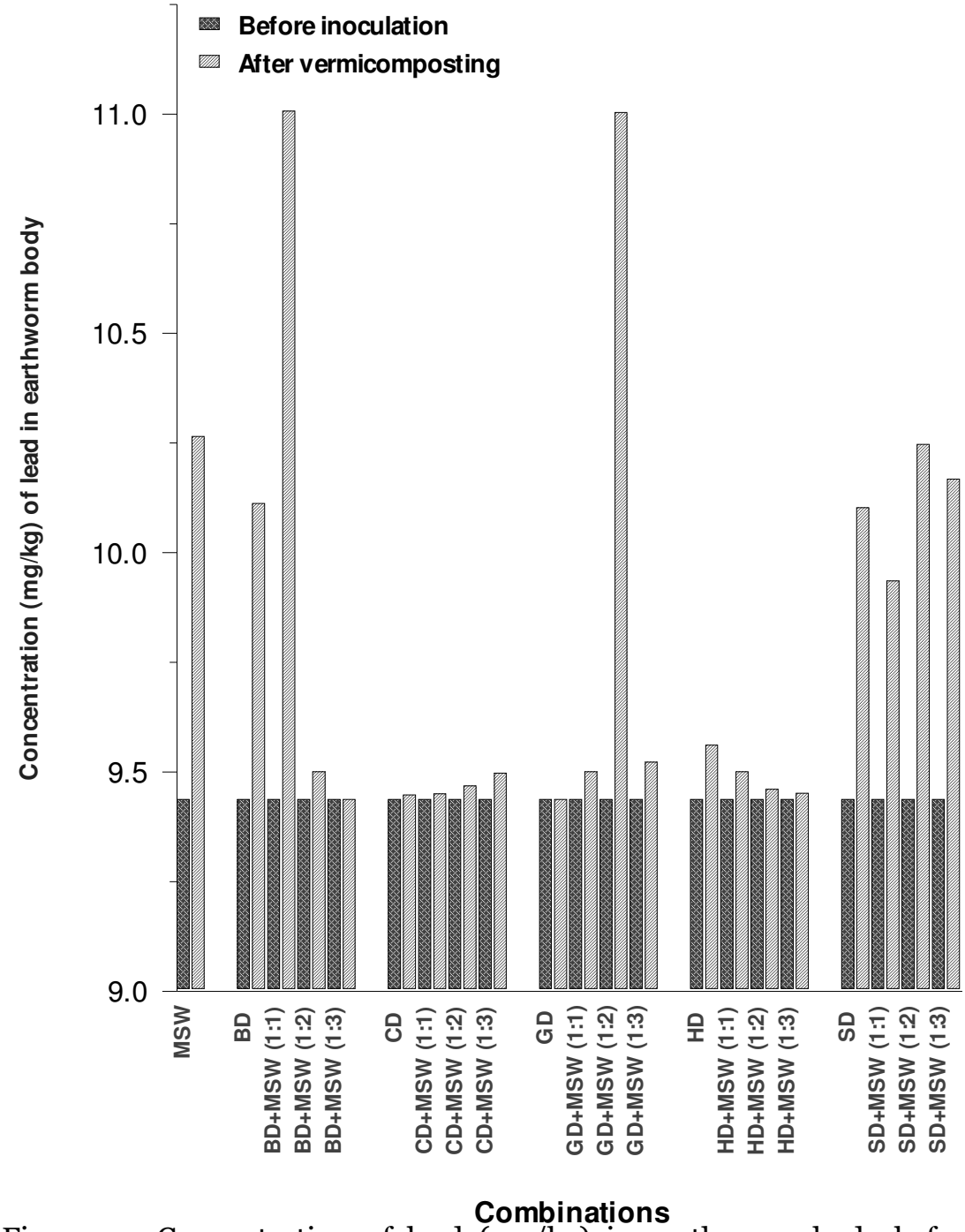



Figure 17. Concentration of lead (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

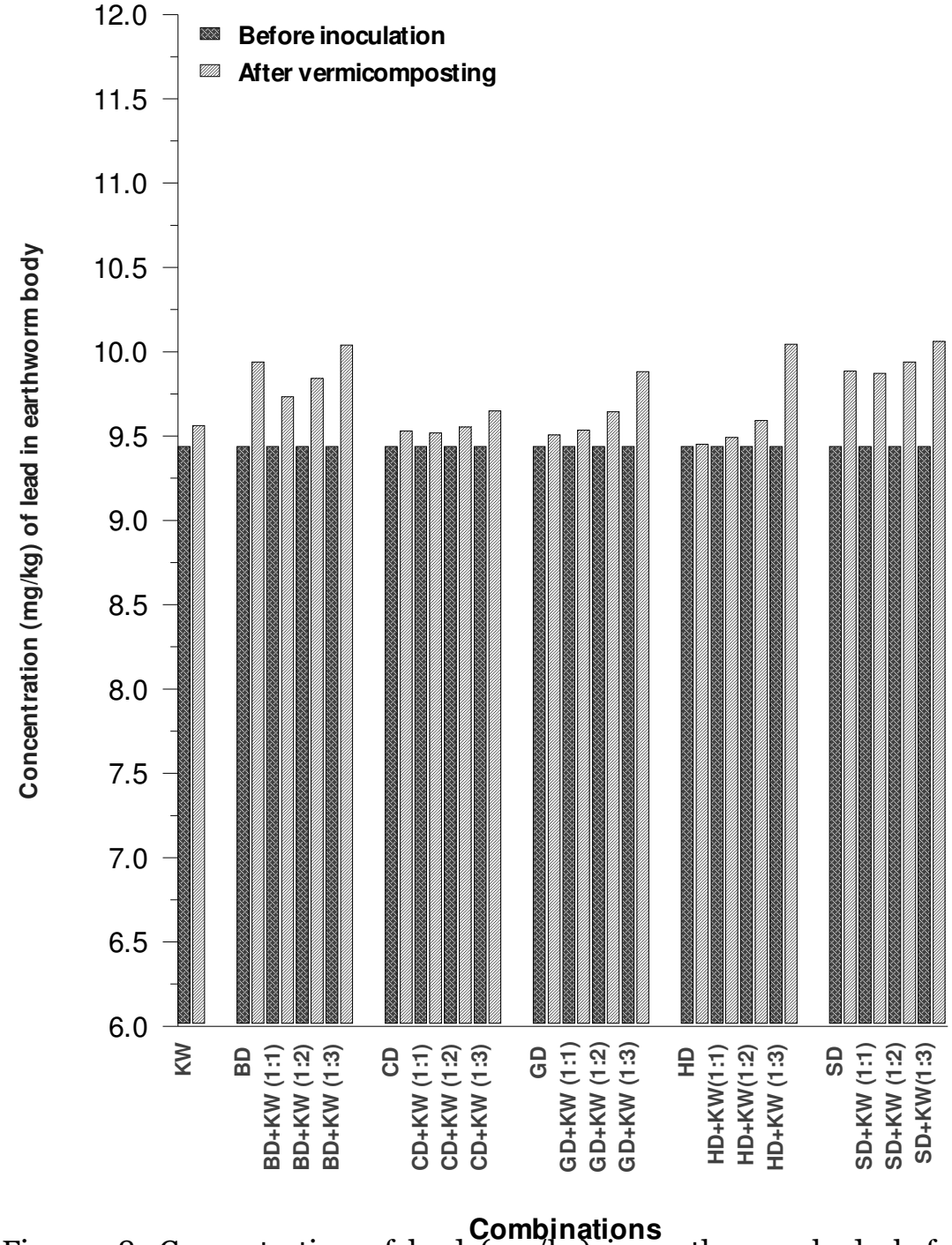



Figure 18. Concentration of lead (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

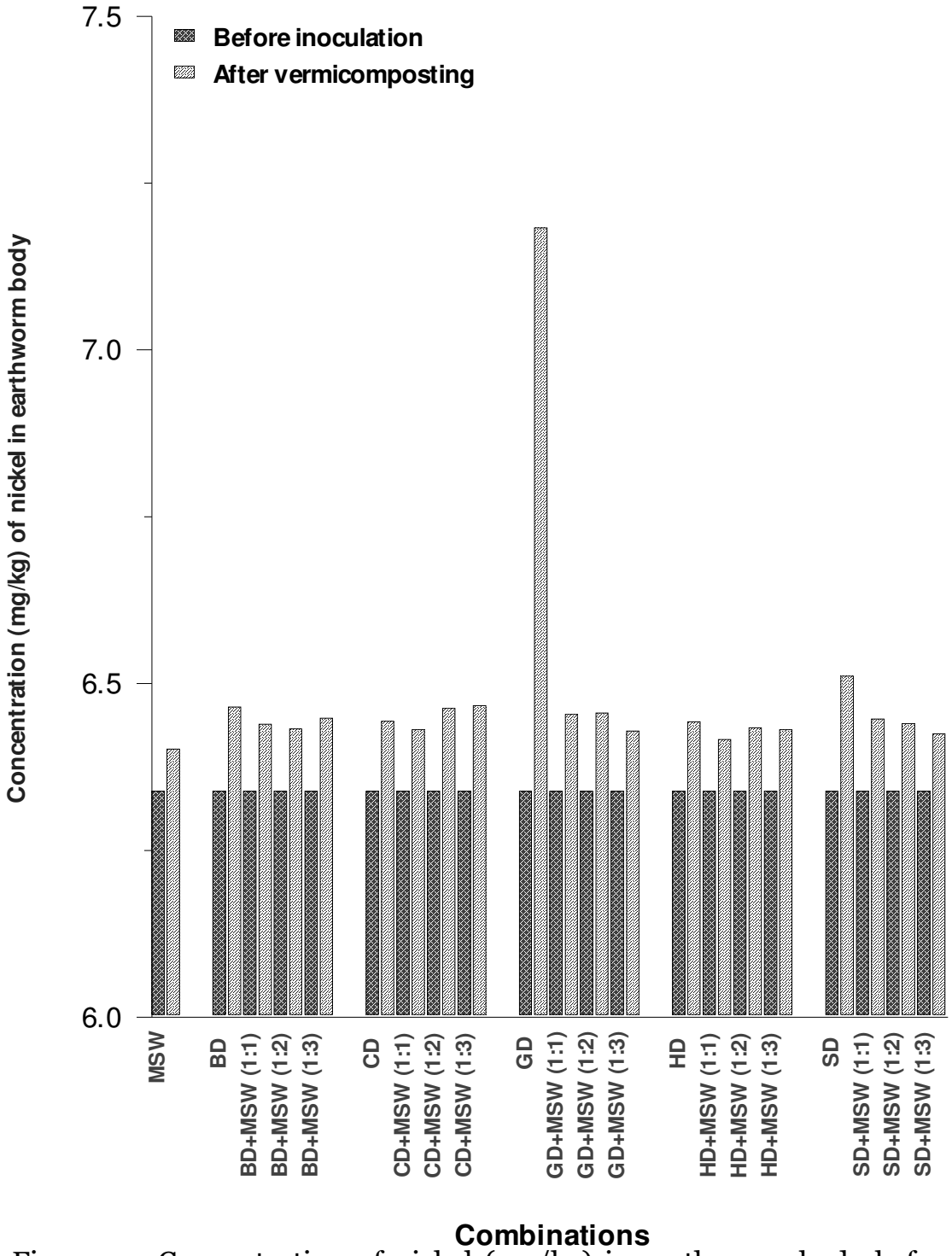



Figure 19. Concentration of nickel (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

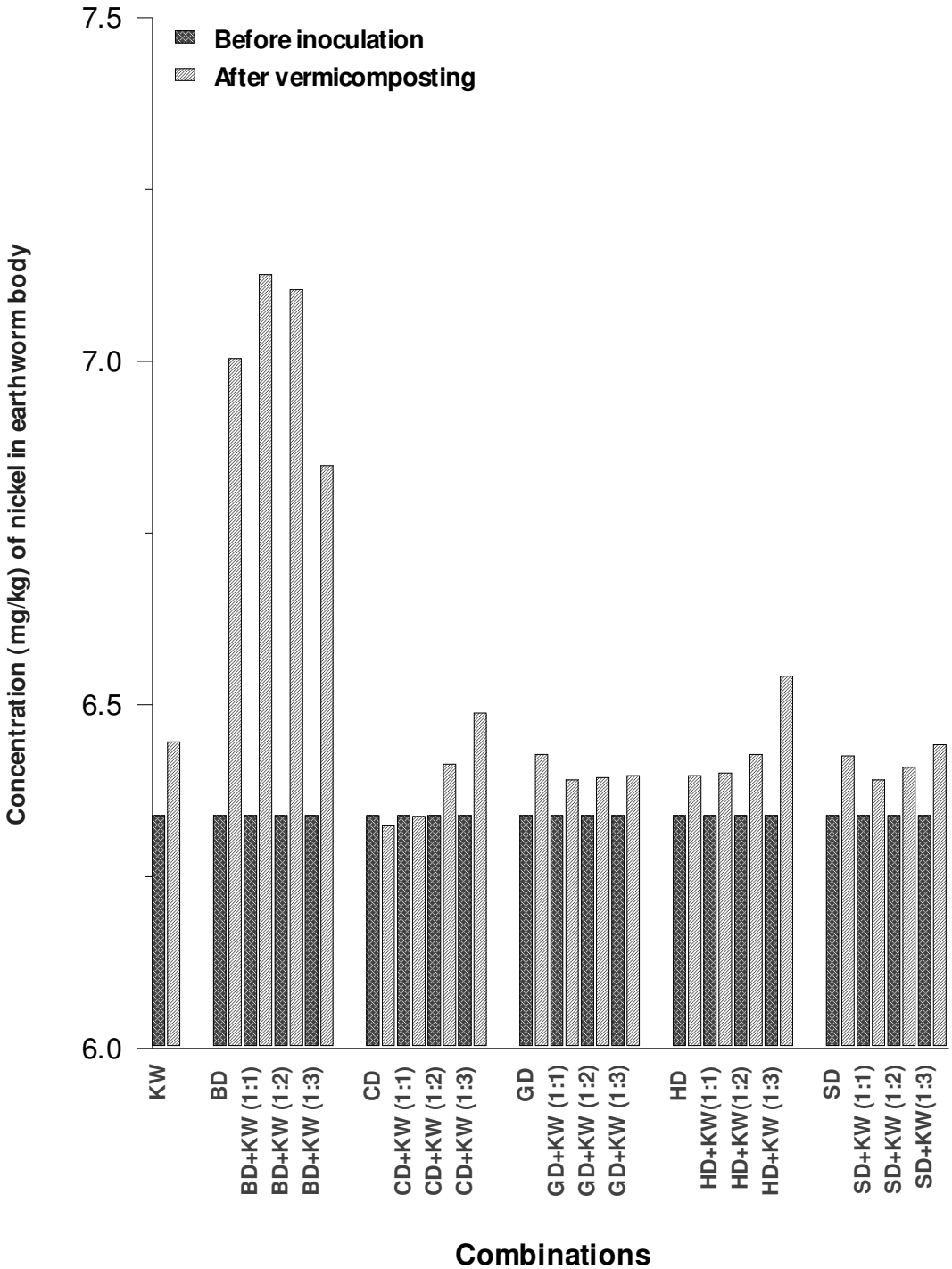



Figure 20. Concentration of nickel (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

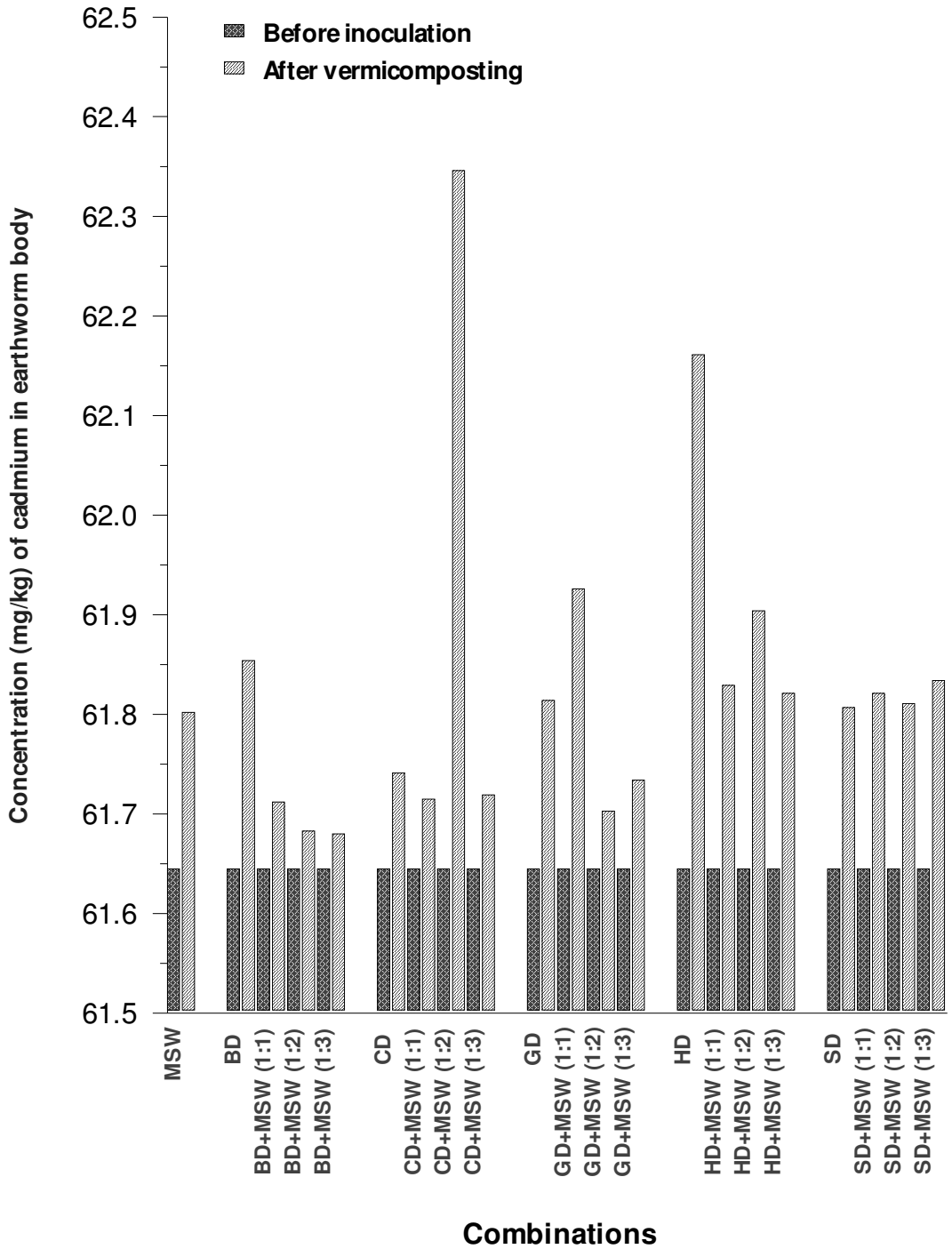



Figure 21. Concentration of cadmium (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

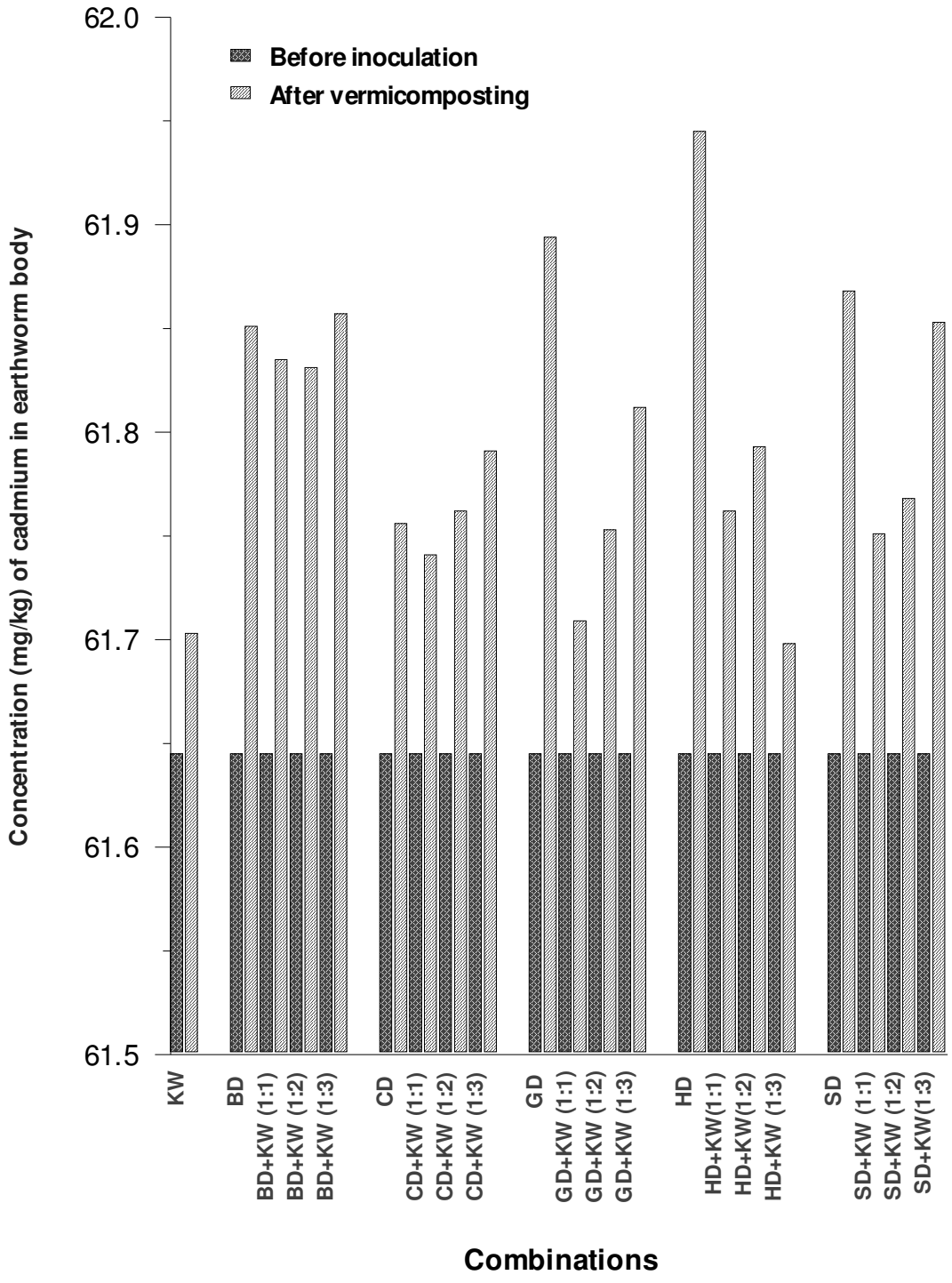



Figure 22. Concentration of cadmium (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

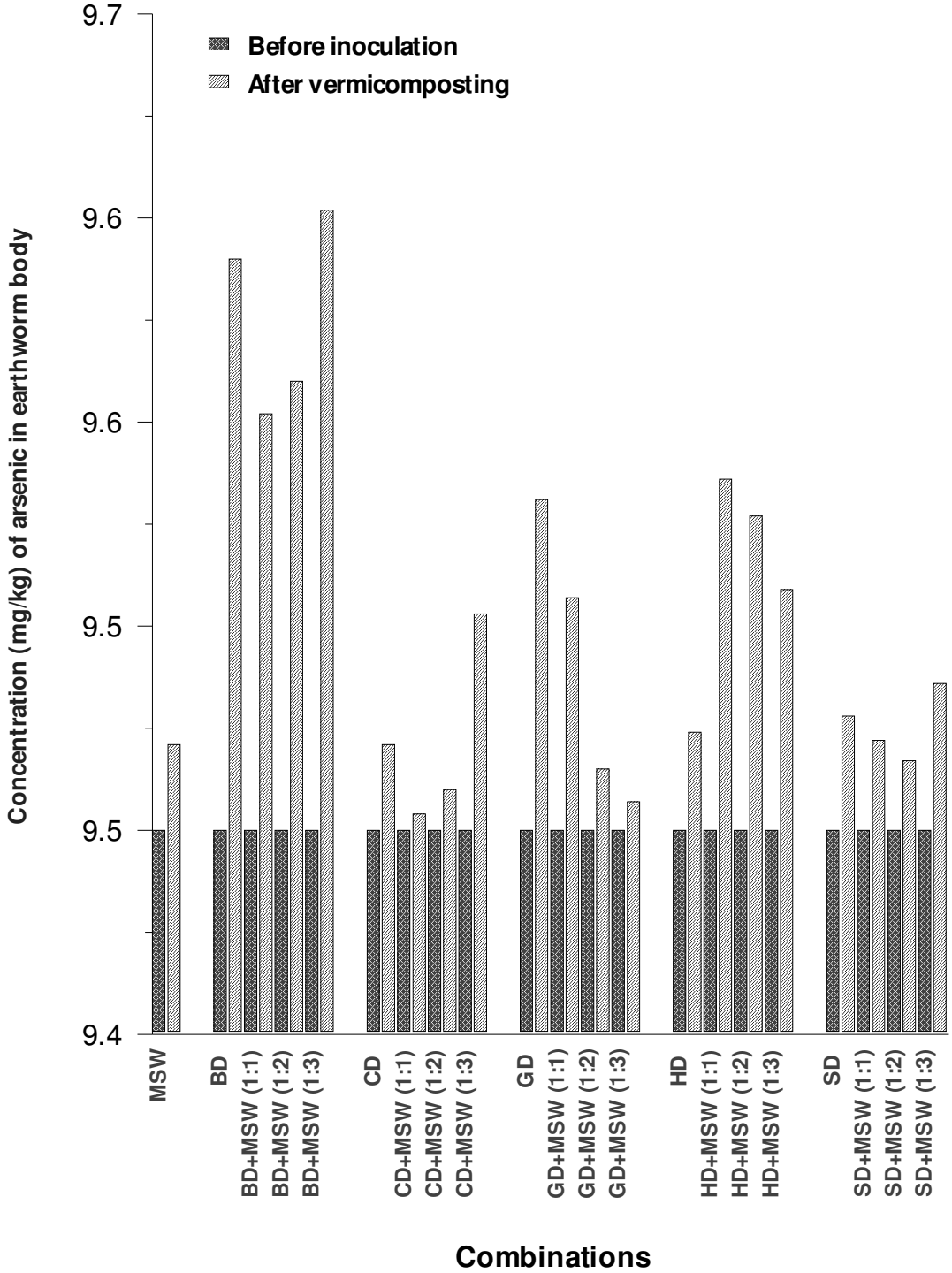



Figure 23. Concentration of arsenic (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with municipal solid wastes.

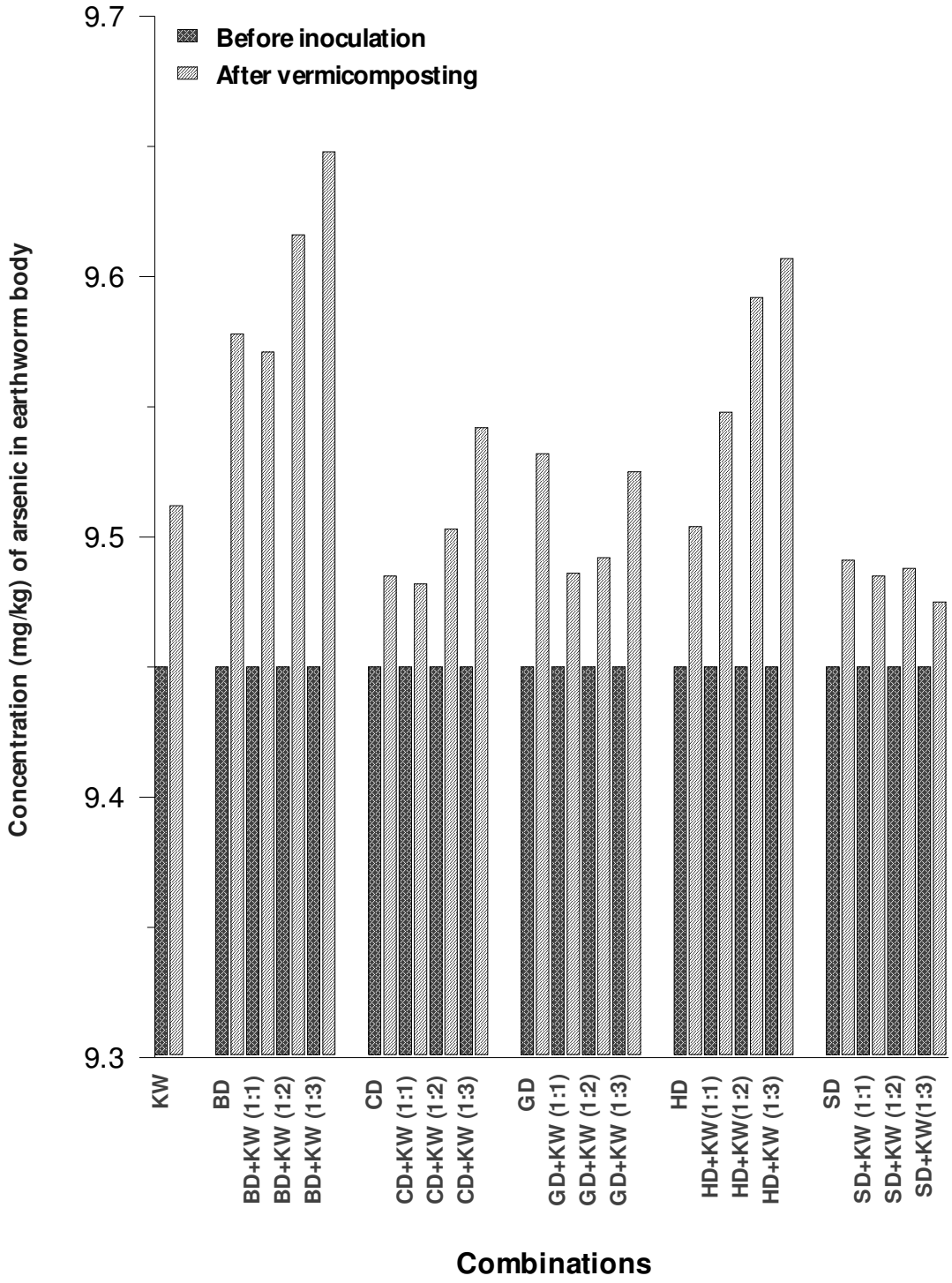



Figure 24. Concentration of arsenic (mg/kg) in earthworm body before inoculation in vermibeds and after vermicomposting of different combinations of animal dungs with kitchen wastes.

# Section – III

## Heavy metals present in the soil, soil with vermicomposts of different animal dungs, body of earthworm (*Eisenia foetida)* and seed grain of crops before sowing and after harvesting of the crops

This section deals with the study of concentration of different heavy metals (Co, Cr, Pb, Ni, Cd and As) in the soil and in the soil with vermicompost of different animal dungs (buffalo, cow, goat, horse and sheep) as well as after inoculation of the earthworm *Eisenia foetida* before sowing and after harvesting the crops. Simultaneously, the heavy metals were estimated in the seeds of crop before sowing and in the grains of crop after its harvesting (Table 20-43 and Figure 25-48). The data demonstrated that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs. It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates the heavy metals from the soil.

Following crops were selected for the present study : Maize (*Zea mays*), pea (*Pisum sativum*), wheat (*Triticum aestivum*) and rice (*Oryza sativa*).

### A. MAIZE (*ZEA MAYS*)

## 1. Cobalt (Co)

The concentration of cobalt significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Co was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (48.21 % decreased, conc. 4.352±0.002 to 2.254±0.006 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (48.00 % decrease, conc. 4.358±0.003 to 2.266±0.003 mg/kg). This decreased concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 28.36 % decreased (conc. 4.365±0.005 to 3.127±0.003 mg/kg) in soil without vermicompost and earthworm and 47.54 % decreased (conc. 4.369±0.005 to 2.292±0.005 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of cobalt was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combinations of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Co 100 % (conc. from 0.068±0.003 mg/kg to below detection limit (BDL)) was observed in the combination of soil with vermicompost of cow dung

inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (20.6 % decrease, conc. 0.068±0.003 to 0.054±0.003 mg/kg). It shows that the amount of cobalt was accumulated by maize plant when sown in the soil (71.78 % increased, conc. 0.068±0.003 to 0.0241±0.007 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*.

The data demonstrated that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of animal dungs. The maximum concentration of Co was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (35.3 %, 2.391±0.005 to 3.693±0.003 mg/kg) was used, followed by soil with buffalo dung (32.6 % increased, conc. 2.391±0.005 to 3.548±0.002 mg/kg) (Table 20 and Figure 25).

## 2. Chromium (Cr)

Data displayed in (Table 21) demonstrated that the concentration of Cr significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Cr was observed to decrease in the

combination of soil with goat dung vermicompost inoculated with earthworm *Eisenia foetida* (37.61 % decreased, conc. 13.120±0.003 to 8.186±0.003 mg/kg), followed by soil with buffalo dung vermicompost inoculated with the earthworm (37.04 % decrease, conc. 13.144±0.003 to 8.275±0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 16.11 % decreased (conc. 13.116±0.005 to 11.003±0.002 mg/kg) in soil without vermicompost and earthworm and 36.99 % decreased (conc. 13.122±0.002 to 8.268±0.004 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Cr was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cr 50.70 % (conc. from 5.531±0.002 to 2.729±0.004 mg/kg) was observed in the combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (49.50 % decrease, conc. 5.531±0.002 to 2.793±0.006 mg/kg). It shows that the amount of chromium was accumulated by maize plant when sown in the soil (14.70 % decreased, conc. 5.531±0.002 to 4.719±0.005 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida* whereas, the

maximum concentration of Cr was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (2.51 %, 101.517±0.003 to 104.134±0.005 mg/kg) was used, followed by soil with buffalo dung (2.22 % increased, conc. 101.517±0.003 to 103.825±0.003 mg/kg) (Figure 26).

## 3. Lead (Pb)

Data displayed in (Table 22) demonstrated that the concentration of lead significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Pb was observed to decrease in the combination of soil with sheep dung vermicompost inoculated with earthworm *Eisenia foetida* (57.58 % decreased, conc. 7.791±0.003 to 3.305±0.006 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (56.55 % decrease, conc. 7.798±0.005 to 3.385±0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 12.0 % increased (conc. 13.116±0.005 to 11.003±0.002 mg/kg) in soil without vermicompost and earthworm and 56.50 % decreased (conc. 13.122±0.002 to 8.268±0.004 mg/kg) in soil with vermicompost of cow dung along with earthworm.

The concentration of lead was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Pb 52.3 % (conc. from 2.497±0.005 to 1.192±0.006 mg/kg) was observed in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with cow dung vermicompost inoculated with earthworm (50.5 % decrease, conc. 2.497±0.005 to 2.793±0.006 mg/kg) in the combination of soil with vermicompost of sheep dung inoculated with earthworm. It shows that the amount of Pb was accumulated by maize plant when sown in the soil (49.6 % decreased, conc. 2.497±0.005 to 1.258±0.003 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of Pb was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (27.3 %, 07.531±0.004 to 07.531±0.004 mg/kg) was used, followed by soil with goat dung (19.6 % increased, conc. 07.531±0.004 to 10.362±0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates lead from the soil (Figure 27).

## 4. Nickel (Ni)

Data displayed in (Table 23) demonstrated that the concentration of nickel significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Ni was observed to decrease in the combination of soil with goat dung vermicompost inoculated with earthworm *Eisenia foetida* (74.9 % decreased, conc. 3.191±0.004 to 0.801±0.003 mg/kg), followed by soil with sheep dung vermicompost inoculated with the earthworm (73.9 % decrease, conc. 3.196±0.002 to 0.835±0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 16.1 % decreased (conc. 3.193±0.003 to 2.680±0.005 mg/kg) in soil without vermicompost and earthworm and 73.8 % decreased (conc. 3.195±0.005 to 0.837±0.002 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Ni was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Ni 63.0 % (conc. from 3.093±0.003 to 1.145±0.003 mg/kg) was observed in the combination

of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (49.50 % decrease, conc. 3.093±0.003 to 1.215±0.005 mg/kg). It shows that the amount of Ni was accumulated by maize plant when sown in the soil (26.9 % decreased, conc. 3.093±0.003 to 2.261±0.003 mg/kg) with respect to the soil with horse dung vermicompost along with earthworm *Eisenia foetida* whereas, the maximum concentration of nickel was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (29.5 %, 3.825±0.003 to 5.425±0.003 mg/kg) was used, followed by soil with buffalo dung (10.7 % increased, conc. 3.825±0.003 to 4.282±0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Ni from the soil (Figure 28).

## 5. Cadmium (Cd)

The concentration of Cd significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Cd was observed to decrease in the combination of soil with sheep dung vermicompost inoculated with earthworm *Eisenia foetida* (63.21% decreased, conc. 5.073±0.004 to 1.879±0.003 mg/kg), followed by soil with goat dung

vermicompost inoculated with the earthworm (62.96 % decrease, conc. 5.085±0.002 to 1.892±0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 38.83 % decreased (conc. 5.073±0.002 to 3.103±0.003 mg/kg) in soil without vermicompost and earthworm and 62.79 % decreased (conc. 5.085±0.002 to 1.892±0.003 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Cd was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cd 86.43 % (conc. from 0.140±0.003 to 0.019±0.003 mg/kg) was observed in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (67.86 % decrease, conc. 0.140±0.003 to 0.045±0.003 mg/kg). It shows that the amount of Cd was accumulated by maize plant when sown in the soil (50.53 % increased, conc. 0.140±0.003 to 0.283±0.005 mg/kg) as compared to the soil with cow dung vermicompost along with earthworm *Eisenia foetida*. The maximum concentration of Cd was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (7.7 %, 38.152±0.003 to 41.323±0.007 mg/kg) was used, followed by soil with

buffalo dung (3.5 % increased, conc. 38.152±0.003 to 39.522±0.006 mg/kg) (Table 24 and Figure 29).

## 6. Arsenic (As)

Table 25 and Figure 30 shows that the concentration of arsenic significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of As was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (62.81 % decreased, conc. 4.172±0.002 to 1.554±0.002 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (62.72 % decrease, conc. 4.172±0.002 to 1.559±0.004 mg/kg). This decreased concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 26.70 % decreased (conc. 4.171±0.005 to 3.058±0.003 mg/kg) in soil without vermicompost and earthworm and 62.50 % decreased (conc. 4.181±0.003 to 1.568±0.006 mg/kg) in soil with vermicompost of horse dung along with earthworm.

The concentration of As was also observed in maize (*Zea mays*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms (*Eisenia*

*foetida*). There was observed the concentration of arsenic from BDL to BDL (below detection limit) was observed in the all combination of soil with vermicompost of inoculated with earthworm and also observed the maximum concentration of As was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (32.8 %, 5.013±0.004 to 7.461±0.002 mg/kg) was used, followed by soil with horse dung (26.1 % increased, conc. 5.013±0.004 to 6.784±0.003 mg/kg) (Figure 30).

## B. PEA (*PISUM SATIVUM*)

### 1. Cobalt (Co)

The concentration of cobalt significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting pea crop. The maximum amount of Co was observed to decrease in the combination of soil with horse dung vermicompost inoculated with earthworm *Eisenia foetida* (55.96 % decreased, conc. 2.509± 0.003 to 1.105 ± 0.006 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (49.88 % decrease, conc. 2.530± 0.005 to 1.268 ± 0.002 mg/kg). This decrease

concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 0.49 % decreased (conc. 2.427± 0.003 to 2.415 ± 0.005 mg/kg) in soil without vermicompost and earthworm and 48.35 % decreased (conc. 2.521± 0.006 to 1.302 ± 0.010 mg/kg) in soil with vermicompost of cow dung along with earthworm.

The concentration of cobalt was also observed in pea (*Pisum sativum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Co 100 % decreased, conc. 0.538 ± 0.004 mg/kg to BDL (below detection limit) was observed in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with cow dung vermicompost inoculated with earthworm (64.50 % decrease, conc. 0.538 ± 0.004 to 0.191 ± 0.002 mg/kg). It shows that the amount of cobalt was accumulated by peas plant when sown in the soil (57.81 % increased, conc. 0.538 ± 0.004 to 0.0241±0.007 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of Co was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (38.40 %, 1.659± 0.003 to 2.693 ± 0.003mg/kg)

was used, followed by soil with buffalo dung (29.31 % increased, conc. 1.659 ± 0.003 to 2. 314 ± 0.003 mg/kg) (Table 26 and Figure 31).

## 2. Chromium (Cr)

Data displayed in (Table 21 and Figure 32 demonstrated that the concentration of Cr significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop. The maximum amount of Cr was observed to decrease in the combination of soil with horse dung vermicompost inoculated with earthworm *Eisenia foetida* (47.71 % decreased, conc. 4.284 ± 0.002 to 2.258 ± 0.005 mg/kg), followed by soil with cow dung vermicompost inoculated with the earthworm (45.71 % decrease, conc. 4.319 ± 0.003 to 2.345 ± 0.004 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 10.34 % decreased (conc. 4.109 ± 0.005 to 3.684 ± 0.003 mg/kg) in soil without vermicompost and earthworm and 39.21 % decreased (conc. 4.213 ± 0.004 to 2.561 ± 0.004 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Cr was also observed in pea (*Pisum sativum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cr 75.58 % (conc. from 1.294 ± 0.002 to 0.316 ± 0.004 mg/kg) was observed in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (62.44 % decrease, conc. 1.294 ± 0.002 to 0.486 ± 0.003 mg/kg). It shows that the amount of cobalt was accumulated by pea plant when sown in the soil (24.81 % decreased, conc. 1.294 ± 0.002 to 0.973 ± 0.003 mg/kg) as compared to the soil without vermicompost along with earthworm *Eisenia foetida* whereas, the maximum concentration of Cr was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (39.33 %, 2.496 ± 0.005 to 4.114 ± 0.004 mg/kg) was used, followed by soil with buffalo dung (20.56 % increased, conc. 2.496 ± 0.005 to 3.142 ± 0.003 mg/kg).

## 3. Lead (Pb)

Table 28 and Figure 23 shown that the concentration of lead significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting pea crop.

The maximum amount of Pb was observed to decrease in the combination of soil with goat dung vermicompost inoculated with earthworm *Eisenia foetida* (17.13 % decreased, conc. 15.945 ± 0.005 to 13.214 ± 0.002 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (17.03 % decrease, conc. 15.942 ± 0.004 to 13.227 ± 0.006 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 1.28 % increased (conc. 15.726 ± 0.003 to 15.524 ± 0.003 mg/kg) in soil without vermicompost and earthworm and 14.37 % decreased (conc. 15.965 ± 0.003 to 13.671 ± 0.007 mg/kg) in soil with vermicompost of cow dung along with earthworm.

The concentration of lead was also observed in pea (*Pisum sativum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Pb 61.73 % (conc. from 3.115 ± 0.003 to 1.192 ± 0.003 mg/kg) was observed in the combination of soil with vermicompost of cow dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (60.29 % decrease, conc. 3.115 ± 0.003 to 1.237 ± 0.006 mg/kg) in the combination of soil with vermicompost of sheep dung inoculated with earthworm. It shows that the amount of Pb was decreased by pea plant when sown in the soil (33.58 % decreased, conc.

3.115 ± 0.003 to 2.069 ± 0.008 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*. The maximum concentration of Pb was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (10.81 %, 11.811 ± 0.003 to 13.242 ± 0.003 mg/kg) was used, followed by soil with goat dung (19.6 % increased, conc. 11.811 ± 0.003 to 12.429 ± 0.006 mg/kg).

## 4. Nickel (Ni)

Table 29 and Figure 34 demonstrated that the concentration of nickel significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting pea crop. The maximum amount of Ni was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (36.38 % decreased, conc. 9.642 ± 0.003 to 6.134 ± 0.003 mg/kg), followed by soil with buffalo dung vermicompost inoculated with the earthworm (73.9 % decrease, conc. 9.701 ± 0.004 to 6.295 ± 0.005 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 7.97 % decreased (conc. 9.511 ± 0.003 to 8.753 ± 0.006 mg/kg) in soil without vermicompost and earthworm and 33.23 % decreased (conc. 9.629 ± 0.003 to 6.429 ±

0.003 mg/kg) in soil with vermicompost of horse dung along with earthworm.

The concentration of Ni was also observed in pea grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms (Figure xxxxxx). The maximum decrease in the concentration of Ni was observed 55.48 % (conc. from 2.572 ± 0.003 to 1.145 ± 0.003 mg/kg) in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (52.76 % decrease, conc. 3.093 ± 0.003 to 1.215±0.005 mg/kg). It shows that the amount of Ni was accumulated by pea plant when sown in the soil (16.63 % increased, conc. 2.572 ± 0.003 to 3.085 ± 0.005 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*. The data demonstrated that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs. The maximum concentration of nickel was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (25.00 %, 5.468 ± 0.002 to 7.291 ± 0.003 mg/kg) was used, followed by soil with buffalo dung (19.20 % increased, conc. 5.468 ± 0.002 to 6.767 ± 0.003 mg/kg).

## 5. Cadmium (Cd)

Data displayed in (Table 30) demonstrated that the concentration of Cd significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting pea crop. The maximum amount of Cd was observed to decrease in the combination of soil with sheep dung vermicompost inoculated with earthworm *Eisenia foetida* (42.83% decreased, conc. 8.422 ± 0.005 to 4.815 ± 0.003 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (38.28 % decrease, conc. 8.504 ± 0.004 to 5.249 ± 0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 13.28 % decreased (conc. 8.372 ± 0.003 to 7.260 ± 0.003 mg/kg) in soil without vermicompost and earthworm and 36.74 % decreased (conc. 8.436 ± 0.004 to 5.337 ± 0.005 mg/kg) in soil with vermicompost of goat dung along with earthworm.

The concentration of Cd was also observed in pea grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cd was observed 98.42 % (conc. 1.206 ± 0.005 to 0.019 ± 0.004 mg/kg) in the combination of soil with

vermicompost of sheep dung inoculated with earthworm followed by soil with horse dung vermicompost inoculated with earthworm (96.27 % decrease, conc. 1.206 ± 0.005 to 0.045 ± 0.003 mg/kg). It shows that the amount of Cd was accumulated by maize plant when sown in the soil (47.77 % increased, conc. 1.206 ± 0.005 to 2.309 ± 0.011 mg/kg) as compared to the soil with different animal dungs vermicompost along with earthworm *Eisenia foetida* whereas, the maximum concentration of Cd was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (43.23 %, 3.289 ± 0.006 to 5.794 ± 0.003 mg/kg) was used, followed by soil with cow dung (3.5 % increased, conc. 3.289 ± 0.006 to 5.761 ± 0.004 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Cd from the soil (Figure 35).

## 6. Arsenic (As)

The concentration of arsenic significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting pea (*Pisum sativum*) crop. The maximum amount of As was observed to decrease in the combination of soil with buffalo dung vermicompost inoculated with earthworm *Eisenia foetida* (53.89 % decreased, conc. 5.244 ± 0.003 to 2.418 ± 0.004 mg/kg),

followed by soil with goat dung vermicompost inoculated with the earthworm (51.58 % decrease, conc. 5.190 ± 0.012 to 2.513 ± 0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 17.89 % decreased (conc. 5.183 ± 0.005 to 4.256 ± 0.004 mg/kg) in soil without vermicompost and earthworm and 51.28 % decreased (conc. 5.386 ± 0.003 to 2.624 ± 0.003 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of As was also observed in pea (*Pisum sativum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of As 100 % (conc. from 0.261 ± 0.003 mg/kg to BDL (below detectible limit)) was observed in the combination of soil with vermicompost of goat dung inoculated with earthworm followed by soil with buffalo dung vermicompost inoculated with earthworm (67.43 % decrease, conc. 0.261 ± 0.003 to 0.085 ± 0.002 mg/kg). It shows that the amount of arsenic was accumulated by maize plant when sown in the soil (20.18 % increased, conc. 0.261 ± 0.003 to 0.327 ± 0.008 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of As was significantly increased in inoculated earthworm body when the combination of soil with sheep dung vermicompost (83.69 %, 0.265 ± 0.002 to 1.625 ± 0.004 mg/kg) was used, followed by soil with horse dung (76.90 % increased, conc. 0.265 ± 0.002 to 1.147 ± 0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates As from the soil after harvesting of pea (*Pisum sativum*) (Table 31, Figure 36).

## C. WHEAT (*TRITICUM AESTIVUM*)

### 1. Cobalt (Co)

Data show in (Table 21) demonstrated that the concentration of cobalt significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting wheat (*Triticum aestivum*). The maximum amount of Co was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (40.75 % decreased, conc. 1.259 ± 0.005 to 0.746 ± 0.004 mg/kg), followed by soil with sheep dung vermicompost inoculated with the earthworm (32.09 % decrease, conc. 1.265± 0.004 to 0.859 ± 0.003 mg/kg). This decrease concentration of heavy metals in other combinations of soil with

vermicompost of animals dung inoculated with earthworms ranged between 1.03 % increased (conc. 1.253 ± 0.002 to 1.266 ± 0.005 mg/kg) in soil without vermicompost and earthworm and 31.56 % decreased (conc. 1.261± 0.003 to 0.863 ± 0.003 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of cobalt was also observed in wheat grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Co was observed (78.96 % decreased, conc. 0.751± 0.005 to 0.158 ± 0.005 mg/kg) in the combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (78.43 % decrease, conc. 0.751± 0.005 to 0.162 ± 0.002 mg/kg). It shows that the amount of cobalt was observed in after the harvesting of wheat plant grain from the soil (45.01 % dereased, conc. 0.751± 0.005 to 0.413 ± 0.008 mg/kg) as compared to the soil with different animal dung vermicompost along with earthworm *Eisenia foetida*. The data demonstrated that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs.

The maximum concentration of Co was significantly increased in inoculated earthworm body when the combination of soil with cow dung

vermicompost (20.75 %, 4.183 ± 0.005 to 5.278 ± 0.002 mg/kg) was used, followed by soil with goat dung (20.34 % increased, conc. 4.183 ± 0.005 to 5.251± 0.005 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates cobalt from the soil (Table 32 and Figure 37).

## 2. Chromium (Cr)

The concentration of Cr significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting wheat (*Triticum aestivum*) crop. The maximum amount of Cr was observed to decrease in the combination of soil with buffalo dung vermicompost inoculated with earthworm *Eisenia foetida* (30.73 % decreased, conc. 9.057 ± 0.004 to 6.237 ± 0.005 mg/kg), followed by soil with cow dung vermicompost inoculated with the earthworm (30.54 % decrease, conc. 9.046 ± 0.003 to 6.254 ± 0.004 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 3.54 % decreased (conc. 9.004 ± 0.003 to 8.685 ± 0.005 mg/kg) in soil without vermicompost and earthworm and 27.98 % decreased (conc. 9.038 ± 0.003 to 6.485 ± 0.002 mg/kg) in soil with vermicompost of goat dung along with earthworm.

The concentration of Cr was also observed in wheat (*Triticum aestivum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cr 82.57 % (conc. from 0.413 ± 0.003 to 0.072 ± 0.005 mg/kg) was observed in the combination of soil with vermicompost of sheep dung inoculated with earthworm followed by soil with horse dung vermicompost inoculated with earthworm (39.95 % decrease, conc. 0.413 ± 0.003 to 0.248 ± 0.003 mg/kg). It shows that the amount of cobalt was accumulated by wheat plant when sown in the soil (23.23 % increased, conc. 0.413 ± 0.003 to 0.538 ± 0.005 mg/kg) as compared to the soil without vermicompost along with earthworm *Eisenia foetida*. The chromium concentration was also increased in the combination of soil with cow dung vermicompost after the harvesting of wheat crop.

However, the maximum concentration of Cr was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (3.81 %, 47.260 ± 0.003 to 49.132± 0.002 mg/kg) was used, followed by soil with buffalo dung (3.80 % increased, conc. 47.260 ± 0.003 to 49.128± 0.002 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Cr from the soil after the harvesting of wheat (*Triticum aestivum*) crop (Table 33 and Figure 38).

## 3. Lead (Pb)

The concentration of lead significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting maize crop (Table 34 and Figure 39). The maximum amount of Pb was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (31.31 % decreased, conc. 5.615± 0.004 to 3.857 ± 0.003 mg/kg), followed by soil with buffalo dung vermicompost inoculated with the earthworm (26.61 % decrease, conc. 5.621 ± 0.003 to 4.125 ± 0.002 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 3.04 % increased (conc. 5.560 ± 0.003 to 5.391 ± 0.003 mg/kg) in soil without vermicompost and earthworm and 25.97 % decreased (conc. 5.629± 0.002 to 4.167 ± 0.005 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of lead was also observed in wheat (*Triticum aestivum*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Pb 58.78 % (conc. from 1.264 ± 0.003 to 1.192 ± 0.003 mg/kg) was observed in the combination of soil with vermicompost of goat dung inoculated with

earthworm followed by soil with cow dung vermicompost inoculated with earthworm (51.42 % decrease, conc. 1.264 ± 0.003 to 0.614 ± 0.003 mg/kg) in the combination of soil with vermicompost of horse dung inoculated with earthworm. It shows that the amount of Pb was decreased by wheat (*Triticum aestivum*) plant when sown in the soil (51.19 % decreased, conc. 1.264 ± 0.003 to 0.617 ± 0.004 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida*.

The data revealed that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs after the harvesting of crop. The maximum concentration of Pb was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (12.06 %, 12.849 ± 0.003 to 14.611± 0.004 mg/kg) was used, followed by soil with goat dung (11.54 % increased, conc. 12.849 ± 0.003 to 14.526± 0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates lead from the soil.

## 4. Nickel (Ni)

The concentration of nickel significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal

dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting wheat crop (Table 35 and Figure 40). The maximum amount of Ni was observed to decrease in the combination of soil with sheep dung vermicompost inoculated with earthworm *Eisenia foetida* (45.56 % decreased, conc1.532 ± 0.005 to 1.532 ± 0.005 mg/kg), followed by soil with horse dung vermicompost inoculated with the earthworm (43.20 % decrease, conc. 1.530 ± 0.004 to 0.869 ± 0.005 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 15.36 % decreased (conc. 1.517 ± 0.004 to 1.284 ± 0.003 mg/kg) in soil without vermicompost and earthworm and 40.69 % decreased (conc. 1.536 ± 0.002 to 0.911 ± 0.002 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Ni was also observed in wheat (*Triticum aestivum*) crop before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Ni was observed 55.72 % (conc. from 0.856 ± 0.002 to 0.379 ± 0.002 mg/kg) in the combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (51.87 % decrease, conc. 0.856 ± 0.002 to 0.412 ± 0.003 mg/kg). It shows that the amount of Ni was accumulated

by wheat plant when sown in the soil (16.47 % increased, conc. 0.856 ± 0.002 to 0.715 ± 0.008 mg/kg) as compared to the soil with horse dung vermicompost along with earthworm *Eisenia foetida* whereas, the maximum concentration of nickel was significantly increased in inoculated earthworm body when the combination of soil with sheep dung vermicompost (26.69 %, 3.326 ± 0.002 to 4.537± 0.002 mg/kg) was used, followed by soil with buffalo dung (19.20 % increased, conc. 3.326 ± 0.002 to 4.408± 0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Ni from the soil.

## 5. Cadmium (Cd)

Table 36 and Figure 41 shows that the concentration of Cd significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting wheat (*Triticum aestivum*) crop. The maximum amount of Cd was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (68.31% decreased, conc. 3.528 ± 0.008 to 1.118 ± 0.005 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (65.21 % decrease, conc. 3.326 ± 0.010 to 1.157 ± 0.004 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of

animals dung inoculated with earthworms ranged between 6.81 % decreased (conc. 3.246± 0.013 to 3.025 ± 0.008 mg/kg) in soil without vermicompost and earthworm and 62.55 % decreased (conc. 3.316 ± 0.007 to 1.242 ± 0.014 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of cadmium was also observed in wheat (*Triticum aestivum*) crop grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cd was observed 61.79 % (conc. 0.615 ± 0.004 to 0.235 ± 0.003 mg/kg) in the combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with buffalo dung vermicompost inoculated with earthworm (46.99 % decrease, conc. 0.615 ± 0.004 to 0.326 ± 0.003 mg/kg). The minimum decrease concentration of Cd was observed in the soil with cow dungs vermicompost along with earthworm *Eisenia foetida* (6.02 % decreased, conc. 0.615 ± 0.004 to 0.578 ± 0.006 mg/kg). The maximum concentration of Cd was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (46.84 %, 1.882 ± 0.005 to 3.540± 0.012 mg/kg) was used, followed by soil with cow dung (20.42 % increased, conc. 1.882 ± 0.005 to 3.362± 0.003 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Cd from the soil.

## 6. Arsenic (As)

The concentration of arsenic significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting wheat (*Triticum aestivum*) crop. The maximum amount of As was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (75.44% decreased, conc. 0.513 ± 0.008 to 0.126 ± 0.014 mg/kg), followed by soil with horse dung vermicompost inoculated with the earthworm (75.12 % decrease, conc. 0.422 ± 0.006 to 0.105 ± 0.009 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 18.01 % decreased (conc. 0.472 ± 0.005 to 0.387 ± 0.012mg/kg) in soil without vermicompost and earthworm and 51.28 % decreased (conc. 5.386 ± 0.003 to 2.624 ± 0.003 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of As was also observed in wheat (*Triticum aestivum*) crop grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease concentration of Cr was observed 100 % in the both combination of soil with vermicompost of

goat and horse dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (45 % decrease, conc. 0.268 ± 0.003 to 0.145 ± 0.009 mg/kg). It shows that the amount of arsenic was accumulated by wheat (*Triticum aestivum*) crop when sown in the soil (18.54 % increased, conc. 0.268 ± 0.003 to 0.268 ±0.003 mg/kg) as compared to the soil with cow dung vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of As was significantly increased in inoculated earthworm body when the combination of soil with horse dung vermicompost (69.29 %, 0.503 ± 0.003 to 1.638± 0.004 mg/kg) was used, followed by soil with cow dung (68.99 % increased, conc. 0.503 ± 0.003 to 1.622± 0.002 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates As from the soil after harvesting of wheat (*Triticum aestivum*) crop (Table 37 and Figure 42).

## D. RICE (*ORYZA SATIVA*)

### 1. Cobalt (Co)

Table 38, demonstrated that the concentration of cobalt significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm

*Eisenia foetida* in its different combinations after harvesting rice (*Oryza sativa*) crop. The maximum amount of Co was observed to decrease in the combination of soil with cow dung vermicompost inoculated with earthworm *Eisenia foetida* (44.04 % decreased, conc. 2.895± 0.015 to 1.620 ± 0.011 mg/kg), followed by soil with buffalo dung vermicompost inoculated with the earthworm (43.98 % decrease, conc. 2.881± 0.008 to 1.614 ± 0.005 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 11.42 % decreased (conc. 2.864 ± 0.013 to 2.537 ± 0.009 mg/kg) in soil without vermicompost and earthworm and 43.92 % decreased (conc. 2.885 ± 0.012 to 1.618 ± 0.013 mg/kg) in soil with vermicompost of goat dung along with earthworm.

The concentration of Co was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Co was observed 100 % decreased in the both combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with goat and sheep dung vermicompost inoculated with earthworm. It shows that the amount of cobalt was observed in after the harvesting of rice plant grain from the soil (60.49 % dereased, conc. 0.286± 0.008 to 0.113± 0.007

mg/kg) as compared to the soil with different animal dung vermicompost along with earthworm *Eisenia foetida*.

The data demonstrated that the earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs after the harvesting of rice (*Oryza sativa*) crop. The maximum concentration of Co was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (37.10 %, 6.182± 0.009 to 9.828± 0.007 mg/kg) was used, followed by soil with goat dung (29.86 % increased, conc. 6.182± 0.009 to 8.814± 0.004 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates cobalt from the soil (Figure 43).

## 2. Chromium (Cr)

Data displayed in (Table 39 and Figure 44) demonstrated that the concentration of Cr significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting rice (*Oryza sativa*) crop. The maximum amount of Cr was observed to decrease in the combination of soil with horse dung vermicompost inoculated with earthworm *Eisenia foetida* (17.20 % decreased, conc. 10.324 ± 0.005 to 8.548 ± 0.008 mg/kg), followed by soil with cow dung vermicompost

inoculated with the earthworm (17.14 % decrease, conc. 10.320 ± 0.013 to 8.551 ± 0.009 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 7.98 % decrease (conc. 10.298 ± 0.010 to 8.559 ± 0.004 mg/kg) in soil without vermicompost and earthworm and 17.12 % decreased (conc. 10.316 ± 0.013 to 8.550 ± 0.011 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of Cr was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cr 92.35 % (conc. from 1.347 ± 0.005 to 0.103 ± 0.006 mg/kg) was observed in the combination of soil with vermicompost of horse dung inoculated with earthworm followed by soil with sheep dung vermicompost inoculated with earthworm (91.46 % decrease, conc. 1.347 ± 0.005 to 0.115 ± 0.011 mg/kg). It shows that the amount of chromium was accumulated by rice plant when sown in the soil (36.75 % increased, conc. 1.347 ± 0.005 to 0.852 ± 0.008 mg/kg) as compared to the soil without vermicompost along with earthworm *Eisenia foetida*. The chromium concentration was also increased in the combination of soil with cow dung vermicompost after the harvesting of rice (*Oryza sativa*) crop.

However, the maximum concentration of Cr was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (17.94 %, 5.913 ± 0.011to 7.206± 0.008 mg/kg) was used, followed by soil with horse dung (17.77 % increased, conc. 5.913 ± 0.011 to 7.191± 0.006 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Cr from the soil after the harvesting of rice (*Oryza sativa*) crop.

## 3. Lead (Pb)

The concentration of lead significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting rice crop (Table 40 and Figure 45). The maximum amount of Pb was observed to decrease in the combination of soil with goat dung vermicompost inoculated with earthworm *Eisenia foetida* (32.72 % decreased, conc. 4.966 ± 0.012 to 3.341 ± 0.008 mg/kg), followed by soil with horse dung vermicompost inoculated with the earthworm (35.35 % decrease, conc. 4.961 ± 0.006 to 3.356 ± 0.013 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 6.45 % increased (conc. 4.948 ± 0.004 to 4.629 ± 0.013 mg/kg) in soil without vermicompost and earthworm and 32.35 % decreased

(conc. 4.973 ± 0.009 to 3.364 ± 0.005 mg/kg) in soil with vermicompost of sheep dung along with earthworm.

The concentration of lead was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Pb 89.80 % (conc. from 0.245 ± 0.011 to 0.025 ± 0.006 mg/kg) was observed in the combination of soil with vermicompost of goat dung inoculated with earthworm followed by soil with horse dung vermicompost inoculated with earthworm (84.90 % decrease, conc. 0.245 ± 0.011 to 0.037 ± 0.012 mg/kg). It shows that the amount of Pb was decreased by rice (*Oryza sativa*) plant accumulate Pb when sown in the soil (37.50 % increased, conc. 0.245 ± 0.011to 0.392 ± 0.006 mg/kg) as compared to the soil with different animal dungs vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of Pb was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (30.14 %, 8.067 ± 0.005 to 11.547± 0.013 mg/kg) was used, followed by soil with goat dung (12.06 % increased, conc. 8.067 ± 0.005 to 9.173± 0.008 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Pb from the soil.

## 4. Nickel (Ni)

Table 41 and Figure 46 shows that the concentration of Ni significantly ($P<0.05$ 't' test) decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting rice (*Oryza sativa*) crop. The maximum amount of nickel was observed to decrease in the combination of soil with horse dung vermicompost inoculated with earthworm *Eisenia foetida* (40.98 % decreased, conc. 5.622 ± 0.012 to 3.318 ± 0.016 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (40.94 % decrease, conc. 5.625 ± 0.015 to 3.322 ± 0.012 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 5.20 % decreased (conc. 5.482 ± 0.013 to 5.197 ± 0.014 mg/kg) in soil without vermicompost and earthworm and 40.93 % decreased (conc. 2.885 ± 0.012 to 1.618 ± 0.013 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of nickel was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Co was observed 65.25 % decreased concentration (0.613 ± 0.009 to 0.213 ± 0.003 mg/kg) in the soil with vermicompost of cow dung inoculated with earthworm followed by soil with horse dung vermicompost inoculated with earthworm. It shows that the amount of Ni was observed in after the harvesting of rice plant grain from the soil (61.99 % decresed, conc. 0.613 ± 0.009 to 0.213 ± 0.003 mg/kg) as compared to

the soil with different animal dung vermicompost along with earthworm *Eisenia foetida*.

The earthworm *Eisenia foetida* was responsible for the accumulation of heavy metals from different combination of soil with vermicompost of different animal dungs after the harvesting of rice (*Oryza sativa*) crop. The maximum concentration of Ni was significantly increased in inoculated earthworm body in the combination of soil with buffalo dung vermicompost (17.12 %, 10.237 ± 0.018 to 12.351± 0.012 mg/kg) was used, followed by soil with cow dung (16.74 % increased, conc. 10.237 ± 0.018 to 12.295± 0.013 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates cobalt from the soil.

## 5. Cadmium (Cd)

Data displayed in (Table 42, Figure 47) demonstrated that the concentration of Cd significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting rice (*Oryza sativa*) crop. The maximum amount of Cd was observed to decrease in the combination of soil with sheep dung vermicompost inoculated with earthworm *Eisenia foetida* (50.23 % decreased, conc. 2.865 ± 0.011 to 1.426 ± 0.009 mg/kg), followed by soil with goat dung vermicompost inoculated with the earthworm (48.85 % decrease, conc. 2.860 ± 0.009 to 1.463 ± 0.016 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 7.42 % decrease (conc. 2.845 ± 0.022 to 2.634 ± 0.014 mg/kg) in soil without vermicompost and earthworm and 48.60 % decreased (conc. 2.858 ± 0.015 to 1.469 ±

0.013 mg/kg) in soil with vermicompost of horse dung along with earthworm.

The concentration of Cd was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of Cd 94.76 % (conc. from 0.267 ± 0.019 to 0.014 ± 0.024 mg/kg) was observed in the combination of soil with vermicompost of cow dung inoculated with earthworm followed by soil with goat dung vermicompost inoculated with earthworm (85.39 % decrease, conc. 0.267 ± 0.019 to 0.039 ± 0.008 mg/kg). It shows that the amount of chromium was accumulated by rice plant when sown in the soil (9.49 % increased, conc. 0.267 ± 0.019 to 0.295± 0.011 mg/kg) as compared to the soil without vermicompost along with earthworm *Eisenia foetida*. The Cd concentration was also decreased in the combination of soil with buffalo and horse dung vermicompost after the harvesting of rice (*Oryza sativa*) crop.

However, the maximum concentration of Cd was significantly increased in inoculated earthworm body when the combination of soil with cow dung vermicompost (46.97 %, 2.264 ± 0.017 to 4.269± 0.014 mg/kg) was used, followed by soil with horse dung (41.21 % increased, conc. 2.264 ± 0.017 to 3.851± 0.009 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates Cr from the soil after the harvesting of rice (*Oryza sativa*) crop.

## 6. Arsenic (As)

The concentration of As significantly decreased in the soil and soil with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida* in its different combinations after harvesting rice crop (Table 43 and Figure 48). The maximum amount of As was observed to decrease in the combination of soil with goat dung vermicompost inoculated with earthworm *Eisenia foetida* (44.51 % decreased, conc. 1.148 ± 0.015 to 0.637 ± 0.024 mg/kg), followed by soil with sheep dung vermicompost inoculated with the earthworm (44.47 % decrease, conc. 1.149 ± 0.013 to 0.638 ± 0.008 mg/kg). This decrease concentration of heavy metals in other combinations of soil with vermicompost of animals dung inoculated with earthworms ranged between 31.54 % decreased (conc. 1.094 ± 0.023 to 0.749 ± 0.015 mg/kg) in soil without vermicompost and earthworm and 44.38 % decreased (conc. 1.165 ± 0.012 to 0.648 ± 0.009 mg/kg) in soil with vermicompost of buffalo dung along with earthworm.

The concentration of As was also observed in rice (*Oryza sativa*) grain before sowing and after harvesting grown in different combination of soil with different animal dungs inoculated with earthworms. The maximum decrease in the concentration of As 70.00 % (conc. from 0.070 ± 0.016 to 0.021 ± 0.009 mg/kg) was observed in the combination of soil with vermicompost of goat dung inoculated with earthworm followed by soil with cow dung vermicompost inoculated with earthworm (65.71 % decrease, conc. 0.070 ± 0.016 to 0.024 ± 0.005 mg/kg). It shows that the amount of Pb was decreased by rice (*Oryza sativa*) plant accumulate As when sown in the soil (21.43 % decreased, conc. 0.070 ± 0.016 to 0.055 ± 0.010 mg/kg) as compared to the soil with different animal dungs vermicompost along with earthworm *Eisenia foetida*.

The maximum concentration of As was significantly increased in inoculated earthworm body when the combination of soil with buffalo dung vermicompost (66.78 %, 1.091 ± 0.023 to 3.284± 0.012 mg/kg) was used, followed by soil with goat dung (66.56 % increased, conc. 1.091 ± 0.023 to 3.263± 0.013 mg/kg). It implies that the earthworm *Eisenia foetida* is a suitable species for vermicomposting that accumulates As from the soil.

Among all the combinations of soil, soil with vermicompost of different animal dungs with municipal solid and kitchen wastes and in earthworm body before and after inoculation in soil as well as before sowing and after harwesting in crops grain, the cobalt and arsenic were significantly decreased in the soil before sowing the maize grain in the combination of soil with vermicompost of goat dung and soil with vermicompost of sheep dung due to inoculation of earthworm *Eisenia foetida* in maize crop field. In maize crop, the level of cobalt was below the detection limit in the combination of soil with vermicompost of cow dung. The chromium and nickel were significantly ($P<0.05$) decreased in the combination of soil with goat dung. The lead and cadmium concentration were observed to decrease in the combination of soil with vermicompost of sheep dung.

The maximum decreased concentration of arsenic (As) were observed in the combination of soil with vermicompost of sheep and goat dung in soil due to inoculation of earthworm *Eisenia foetida* activity in pea crop field whereas maximum decreased in the cobalt and arsenic were observed in the pea grain after the harvesting from the both combination of soil with vermicompost of goat and horse dung. The concentration of arsenic was significantly ($P<0.05$) decreased to the below detection limit in wheat grain in combination of soil with

vermicompost of goat dung as well as soil with vermicompost of horse dung, respectively. The concentration of cobalt was significantly ($P<0.05$) decreased to the below detection limit in rice grain in combination of soil with vermicompost of goat dung as well as soil with vermicompost of sheep dung, respectively.

Thus, the data demonstrated that the concentration of all heavy metals examined in the present study were significantly ($P<0.05$) increased in body of earthworm *Eisenia foetida* from agricultural field of maize, pea, wheat and also observed in rice crop field due to the accumulation of these metals in the earthworm body tissue. The cobalt concentration was remediated from the combination of soil with vermicompost of horse dung in maize crop field due to the accumulation of metals in earthworm body.

The arsenic concentration was remediated from pea crop field due to the accumulation of metals in earthworm body in the combination of soil with vermicompost of horse dung whereas, wheat and rice crop field due to the accumulation of metals in earthworm body in the combination of soil with vermicompost of buffalo dung, respectively.

Table 20. Concentration of cobalt (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of cobalt (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 4.365±0.005 | 3.127±0.003 | 28.36 | 0.068±0.003 | 0.241±0.007* | 71.78 | - | - | - |
| Soil + VC of BD + Ef | 4.369±0.004* | 2.292± 0.005* | 47.54 | 0.068±0.003 | 0.072±0.002* | 5.56 | 2.391±0.005 | 3.548±0.002* | 32.6 |
| Soil + VC of CD + Ef | 4.352±0.002* | 2.254±0.006* | 48.21 | 0.068±0.003 | BDL | -100.00 | 2.391±0.005 | 3.211±0.004* | 25.5 |
| Soil + VC of GD +Ef | 4.358±0.003* | 2.266±0.003* | 48.00 | 0.068±0.003 | 0.054±0.005* | -20.59 | 2.391±0.005 | 3.275±0.003* | 27.0 |
| Soil + VC of HD + Ef | 4.380±0.005* | 2.335±0.003* | 46.69 | 0.068±0.003 | 0.091±0.003* | 25.27 | 2.391±0.005 | 3.693±0.003* | 35.3 |
| Soil + VC of SD +Ef | 4.365±0.003* | 2.319±0.002* | 46.87 | 0.068±0.003 | 0.059±0.003* | -13.24 | 2.391±0.005 | 3.238±0.002* | 26.2 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 21. Concentration of chromium (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of chromium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 13.116±0.005 | 11.003±0.002 | 16.11 | 5.531±0.002 | 4.719±0.005 | 14.7 | - | - | - |
| Soil+VC of BD+Ef | 13.144±0.003* | 8.275±0.003* | 37.04 | 5.531±0.002 | 3.013±0.003* | 45.5 | 101.517±0.003 | 103.825±0.003* | 2.22 |
| Soil+VC of CD+Ef | 13.123±0.002* | 8.269±0.005* | 36.99 | 5.531±0.002 | 2.751±0.004* | 50.3 | 101.517±0.003 | 104.134±0.005* | 2.51 |
| Soil+VC of GD +Ef | 13.120±0.003* | 8.186±0.003* | 37.61 | 5.531±0.002 | 2.835±0.003* | 48.7 | 101.517±0.003 | 103.729±0.002* | 2.13 |
| Soil+VC of HD+Ef | 13.126±0.004* | 8.272±0.006* | 36.98 | 5.531±0.002 | 2.729±0.004* | 50.7 | 101.517±0.003 | 103.745±0.002* | 2.15 |
| Soil+VC of SD +Ef | 13.122±0.002* | 8.268±0.004* | 36.99 | 5.531±0.002 | 2.793±0.006* | 49.5 | 101.517±0.003 | 103.683±0.002* | 2.09 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 22. Concentration of lead (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of lead (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % Change | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 7.790±0.005 | 8.852±0.003 | 12.00 | 2.497±0.005 | 2.619±0.007* | 4.9 | - | - | - |
| Soil+VC of BD+Ef | 7.825±0.002* | 3.569±0.005* | -54.39 | 2.497±0.005 | 1.258±0.003* | -49.6 | 07.531±0.004 | 10.322±0.006* | 27.0 |
| Soil+VC of CD+Ef | 7.798±0.005* | 3.392±0.007* | -56.50 | 2.497±0.005 | 1.192±0.006* | -52.3 | 07.531±0.004 | 09.795±0.003* | 23.1 |
| Soil+VC of GD +Ef | 7.790±0.003* | 3.385±0.003* | -56.55 | 2.497±0.005 | 1.831±0.003* | -26.7 | 07.531±0.004 | 09.362±0.004* | 19.6 |
| Soil+VC of HD+Ef | 7.801±0.004* | 3.416±0.002* | -56.21 | 2.497±0.005 | 1.593±0.005* | -36.2 | 07.531±0.004 | 10.362±0.003* | 27.3 |
| Soil+VC of SD +Ef | 7.791±0.003* | 3.305±0.006* | -57.58 | 2.497±0.005 | 1.237±0.002* | -50.5 | 07.531±0.004 | 09.501±0.005* | 20.7 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 23. Concentration of nickel (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of nickel (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 3.193±0.003 | 2.680±0.005 | 16.1 | 3.093±0.003 | 2.261±0.003* | 26.9 | -- | - | - |
| Soil+VC of BD+Ef | 3.195±0.005* | 0.837±0.002* | 73.8 | 3.093±0.003 | 1.474±0.003* | 52.3 | 3.825±0.003 | 4.691±0.004* | 18.5 |
| Soil+VC of CD+Ef | 3.207±0.004* | 0.978±0.003* | 69.5 | 3.093±0.003 | 1.924±0.004* | 37.8 | 3.825±0.003 | 5.425±0.003* | 29.5 |
| Soil+VC of GD +Ef | 3.191±0.004* | 0.801±0.003* | 74.9 | 3.093±0.003 | 1.215±0.005* | 60.7 | 3.825±0.003 | 4.519±0.007* | 15.4 |
| Soil+VC of HD+Ef | 3.201±0.003* | 0.988±0.006* | 69.1 | 3.093±0.003 | 1.429±0.003* | 53.8 | 3.825±0.003 | 4.426±0.002* | 13.6 |
| Soil+VC of SD +Ef | 3.196±0.002* | 0.835±0.003* | 73.9 | 3.093±0.003 | 1.145±0.003* | 63.0 | 3.825±0.003 | 4.282±0.003* | 10.7 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 24. Concentration of cadmium (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of cadmium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 5.073±0.002 | 3.103±0.003 | 38.83 | 0.140±0.003 | 0.283±0.005* | 50.53 | - | - | - |
| Soil+VC of BD+Ef | 5.176±0.003* | 2.114±0.004* | 59.16 | 0.140±0.003 | 0.135±0.005* | -3.57 | 38.152±0.003 | 41.323±0.007* | 7.7 |
| Soil+VC of CD+Ef | 5.102±0.003* | 1.953±0.007* | 61.72 | 0.140±0.003 | 0.152±0.007* | 7.89 | 38.152±0.003 | 40.763±0.005* | 6.4 |
| Soil+VC of GD +Ef | 5.073±0.004* | 1.879±0.003* | 62.96 | 0.140±0.003 | 0.116±0.002* | -17.14 | 38.152±0.003 | 39.642±0.003* | 3.8 |
| Soil+VC of HD+Ef | 5.085±0.002* | 1.892±0.003* | 62.79 | 0.140±0.003 | 0.045±0.003* | -67.86 | 38.152±0.003 | 39.522±0.006* | 3.5 |
| Soil+VC of SD +Ef | 5.075±0.003* | 1.867±0.005* | 63.21 | 0.140±0.003 | 0.019±0.003* | -86.43 | 38.152±0.003 | 40.335±0.003* | 5.4 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 25. Concentration of arsenic (mg/kg) in experimental soil, maize grain and earthworm body before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of arsenic (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In maize crop grain | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 4.171±0.005 | 3.058±0.003 | 26.70 | BDL | BDL | 0 | - | - | - |
| Soil+VC of BD+Ef | 4.169±0.005* | 1.599±0.004* | 61.60 | BDL | BDL | 0 | 5.013±0.004 | 6.845±0.002* | 26.8 |
| Soil+VC of CD+Ef | 4.172±0.002* | 1.554±0.002* | 62.81 | BDL | BDL | 0 | 5.013±0.004 | 6.309±0.003* | 20.5 |
| Soil+VC of GD +Ef | 4.176±0.006* | 1.559±0.004* | 62.72 | BDL | BDL | 0 | 5.013±0.004 | 6.912±0.006* | 27.5 |
| Soil+VC of HD+Ef | 4.181±0.003* | 1.568±0.006* | 62.50 | BDL | BDL | 0 | 5.013±0.004 | 7.461±0.002* | 32.8 |
| Soil+VC of SD +Ef | 4.170±0.005* | 1.562±0.003* | 62.51 | BDL | BDL | 0 | 5.013±0.004 | 6.784±0.003* | 26.1 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of maize crop grain are significant at $P<0.05$ (t-test).

Table 26. Concentration of cobalt (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of cobalt (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % Decrease | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 2.427±0.003 | 2.415 ± 0.005 | 0.49 | 0.538± 0.004 | 0.692 ± 0.004* | 22.25 | - | - | - |
| Soil+VC of BD+Ef | 2.605± 0.002* | 1.413 ± 0.003* | 45.76 | 0.538± 0.004 | 0.283 ± 0.003* | -47.40 | 1.659± 0.003 | 2.136 ± 0.005* | 22.33 |
| Soil+VC of CD+Ef | 2.521± 0.006* | 1.302 ± 0.010* | 48.35 | 0.538± 0.004 | 0.191 ± 0.002* | -64.50 | 1.659± 0.003 | 2.314± 0.003* | 29.31 |
| Soil+VC of GD +Ef | 2.530± 0.005* | 1.268 ± 0.002* | 49.88 | 0.538± 0.004 | 0.294 ± 0.002* | -45.35 | 1.659± 0.003 | 2.275 ± 0.002* | 27.08 |
| Soil+VC of HD+Ef | 2.509± 0.003* | 1.105 ± 0.006* | 55.96 | 0.538± 0.004 | 0.227 ± 0.003* | -57.81 | 1.659± 0.003 | 2.693 ± 0.003* | 38.40 |
| Soil+VC of SD +Ef | 2.533± 0.003* | 1.348 ± 0.003* | 46.78 | 0.538± 0.004 | BDL | -100.00 | 1.659± 0.003 | 2.238 ± 0.004* | 25.87 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea grain are significant at $P<0.05$ (t-test).

Table 27. Concentration of chromium (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of chromium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % decrease | Before sowing | After Harvesting | % increase |
| Soil control | 4.109 ± 0.005 | 3.684 ± 0.003 | 10.34 | 1.294 ± 0.002 | 0.973± 0.003* | 24.81 | - | - | - |
| Soil+VC of BD+Ef | 4.213 ± 0.004* | 2.561 ± 0.004* | 39.21 | 1.294 ± 0.002 | 0.547 ± 0.005* | 57.73 | 2.496 ± 0.005 | 4.114 ± 0.004* | 39.33 |
| Soil+VC of CD+Ef | 4.319 ± 0.003* | 2.345 ± 0.004* | 45.71 | 1.294 ± 0.002 | 0.821 ± 0.002* | 36.55 | 2.496 ± 0.005 | 3.526 ± 0.002* | 29.21 |
| Soil+VC of GD +Ef | 4.215 ± 0.002* | 2.746 ± 0.003* | 34.85 | 1.294 ± 0.002 | 0.486 ± 0.003* | 62.44 | 2.496 ± 0.005 | 3.142 ± 0.003* | 20.56 |
| Soil+VC of HD+Ef | 4.284 ± 0.002* | 2.258 ± 0.005* | 47.29 | 1.294 ± 0.002 | 0.624 ± 0.003* | 51.78 | 2.496 ± 0.005 | 3.168 ± 0.002* | 21.21 |
| Soil+VC of SD +Ef | 4.322 ± 0.003* | 2.344 ± 0.003* | 10.34 | 1.294 ± 0.002 | 0.316 ± 0.004* | 75.58 | 2.496 ± 0.005 | 3.315 ± 0.003* | 24.71 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea crop grain are significant at $P<0.05$ (t-test).

Table 28. Concentration of lead (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentrations of lead (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 15.726 ± 0.003 | 15.524 ± 0.003 | 1.28 | 3.115 ± 0.003 | 2.069 ± 0.008* | 33.58 | - | - | - |
| Soil+VC of BD+Ef | 16.132 ± 0.002* | 14.157 ± 0.004* | 12.24 | 3.115 ± 0.003 | 1.258 ± 0.002* | 59.61 | 11.811 ± 0.003 | 12.895 ± 0.003* | 8.41 |
| Soil+VC of CD+Ef | 15.811 ± 0.003* | 13.625 ± 0.003* | 13.83 | 3.115 ± 0.003 | 1.192 ± 0.003* | 61.73 | 11.811 ± 0.003 | 13.242 ± 0.003* | 10.81 |
| Soil+VC of GD +Ef | 15.945 ± 0.005* | 13.214 ± 0.002* | 17.13 | 3.115 ± 0.003 | 1.831 ± 0.003* | 41.22 | 11.811 ± 0.003 | 12.568 ± 0.005* | 6.02 |
| Soil+VC of HD+Ef | 15.942 ± 0.004* | 13.227 ± 0.006* | 17.03 | 3.115 ± 0.003 | 1.593 ± 0.003* | 48.86 | 11.811 ± 0.003 | 12.429 ± 0.006* | 4.97 |
| Soil+VC of SD +Ef | 15.965 ± 0.003* | 13.671 ± 0.007* | 14.37 | 3.115 ± 0.003 | 1.237 ± 0.006* | 60.29 | 11.811 ± 0.003 | 12.964 ± 0.003* | 8.89 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea crop grain are significant at $P<0.05$ (t-test).

Table 29. Concentration of nickel (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of nickel (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 9.511 ± 0.003 | 8.753 ± 0.006 | 7.97 | 2.572 ± 0.003 | 3.085± 0.005* | 16.63 | - | - | - |
| Soil+VC of BD+Ef | 9.701 ± 0.004* | 6.295 ± 0.005* | 35.11 | 2.572 ± 0.003 | 1.474 ± 0.002* | -42.69 | 5.468 ± 0.002 | 7.291 ± 0.003* | 25.00 |
| Soil+VC of CD+Ef | 9.642 ± 0.003* | 6.134 ± 0.003* | 36.38 | 2.572 ± 0.003 | 1.924 ± 0.005* | -25.19 | 5.468 ± 0.002 | 6.767 ± 0.003* | 19.20 |
| Soil+VC of GD +Ef | 9.684 ± 0.002* | 6.925 ± 0.004* | 28.49 | 2.572 ± 0.003 | 1.215 ± 0.006* | -52.76 | 5.468 ± 0.002 | 6.815 ± 0.005* | 19.77 |
| Soil+VC of HD+Ef | 9.629 ± 0.003* | 6.429 ± 0.003* | 33.23 | 2.572 ± 0.003 | 1.429 ± 0.004* | -44.44 | 5.468 ± 0.002 | 6.354 ± 0.003* | 13.94 |
| Soil+VC of SD +Ef | 9.635 ± 0.002* | 6.551 ± 0.004* | 32.01 | 2.572 ± 0.003 | 1.145 ± 0.003* | -55.48 | 5.468 ± 0.002 | 6.927 ± 0.003* | 21.06 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea crop grain are significant at $P<0.05$ (t-test).

Table 30. Concentration of cadmium (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of cadmium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 8.372 ± 0.003 | 7.260 ± 0.003 | 13.28 | 1.206 ± 0.005 | 2.309± 0.011* | 47.77 | - | - | - |
| Soil+VC of BD+Ef | 8.525 ± 0.003* | 5.428 ± 0.004* | 36.33 | 1.206 ± 0.005 | 0.135 ± 0.002* | -88.81 | 3.289 ± 0.006 | 5.794 ± 0.003* | 43.23 |
| Soil+VC of CD+Ef | 8.504 ± 0.004* | 5.249 ± 0.003* | 38.28 | 1.206 ± 0.005 | 0.152 ± 0.003* | -87.40 | 3.289 ± 0.006 | 5.761 ± 0.004* | 42.91 |
| Soil+VC of GD +Ef | 8.436 ± 0.004* | 5.337 ± 0.005* | 36.74 | 1.206 ± 0.005 | 0.116 ± 0.002* | -90.38 | 3.289 ± 0.006 | 4.915 ± 0.004* | 33.08 |
| Soil+VC of HD+Ef | 8.465 ± 0.003* | 5.620 ± 0.006* | 33.61 | 1.206 ± 0.005 | 0.045 ± 0.003* | -96.27 | 3.289 ± 0.006 | 5.293 ± 0.003* | 37.86 |
| Soil+VC of SD +Ef | 8.422 ± 0.005* | 4.815 ± 0.003* | 42.83 | 1.206 ± 0.005 | 0.019 ± 0.004* | -98.42 | 3.289 ± 0.006 | 4.697 ± 0.003* | 29.98 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea crop grain are significant at $P<0.05$ (t-test

Table 31. Concentration of arsenic (mg/kg) in experimental soil, pea grain and earthworm body before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of arsenic (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In pea crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 5.183 ± 0.005 | 4.256 ± 0.004 | 17.89 | 0.261 ± 0.003 | 0.327± 0.008* | 20.18 | - | - | - |
| Soil+VC of BD+Ef | 5.386 ± 0.003* | 2.624 ± 0.003* | 51.28 | 0.261 ± 0.003 | 0.085 ± 0.002* | -67.43 | 0.265 ± 0.002 | 1.147 ± 0.003* | 76.90 |
| Soil+VC of CD+Ef | 5.244 ± 0.003* | 2.418 ± 0.004* | 53.89 | 0.261 ± 0.003 | 0.134 ± 0.003* | -48.66 | 0.265 ± 0.002 | 1.326 ± 0.002* | 80.02 |
| Soil+VC of GD +Ef | 5.190 ± 0.002* | 2.513 ± 0.003* | 51.58 | 0.261 ± 0.003 | BDL | -100.00 | 0.265 ± 0.002 | 1.302 ± 0.002* | 79.65 |
| Soil+VC of HD+Ef | 5.391 ± 0.004* | 2.947 ± 0.005* | 45.33 | 0.261 ± 0.003 | 0.171 ± 0.004* | -34.48 | 0.265 ± 0.002 | 1.614 ± 0.003* | 83.58 |
| Soil+VC of SD +Ef | 5.247 ± 0.004* | 2.802 ± 0.005* | 46.60 | 0.261 ± 0.003 | 0.162 ± 0.003* | -37.93 | 0.265 ± 0.002 | 1.625 ± 0.004* | 83.69 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of pea crop grain are significant at $P<0.05$ (t-test).

Table 32. Concentration of cobalt (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of cobalt (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % change | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 1.253 ± 0.002 | 1.266 ± 0.005 | 1.03 | 0.751± 0.005 | 0.413± 0.008* | 45.01 | - | - | - |
| Soil+VC of BD+Ef | 1.261± 0.003* | 0.863 ± 0.003* | -31.56 | 0.751± 0.005 | 0.294 ± 0.003* | 60.85 | 4.183 ± 0.005 | 5.265± 0.004* | 20.55 |
| Soil+VC of CD+Ef | 1.259± 0.005* | 0.746 ± 0.004* | -40.75 | 0.751± 0.005 | 0.163 ± 0.003* | 78.30 | 4.183 ± 0.005 | 5.278± 0.002* | 20.75 |
| Soil+VC of GD +Ef | 1.268± 0.002* | 0.905 ± 0.002* | -28.63 | 0.751± 0.005 | 0.197 ± 0.004* | 73.77 | 4.183 ± 0.005 | 5.251± 0.005* | 20.34 |
| Soil+VC of HD+Ef | 1.257± 0.005* | 0.942 ± 0.002* | -25.06 | 0.751± 0.005 | 0.158 ± 0.005* | 78.96 | 4.183 ± 0.005 | 5.269± 0.003* | 20.61 |
| Soil+VC of SD +Ef | 1.265± 0.004* | 0.859 ± 0.003* | -32.09 | 0.751± 0.005 | 0.162 ± 0.002* | 78.43 | 4.183 ± 0.005 | 5.257± 0.003* | 20.43 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 33. Concentration of chromium (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of chromium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 9.004 ± 0.003 | 8.685 ± 0.005 | 3.54 | 0.413 ± 0.003 | 0.538 ± 0.005* | 23.23 | - | - | - |
| Soil+VC of BD+Ef | 9.057 ± 0.004* | 6.237 ± 0.005* | 30.73 | 0.413 ± 0.003 | 0.256 ± 0.002* | -38.01 | 47.260 ± 0.003 | 49.128± 0.002* | 3.80 |
| Soil+VC of CD+Ef | 9.038 ± 0.003* | 6.485 ± 0.002* | 27.98 | 0.413 ± 0.003 | 0.946 ± 0.005* | 56.34 | 47.260 ± 0.003 | 49.115± 0.005* | 3.78 |
| Soil+VC of GD +Ef | 9.046 ± 0.003* | 6.254 ± 0.004* | 30.54 | 0.413 ± 0.003 | 0.265 ± 0.006* | -35.84 | 47.260 ± 0.003 | 48.850± 0.006* | 3.25 |
| Soil+VC of HD+Ef | 9.053 ± 0.005* | 6.749 ± 0.008* | 25.04 | 0.413 ± 0.003 | 0.248 ± 0.003* | -39.95 | 47.260 ± 0.003 | 49.132± 0.002* | 3.81 |
| Soil+VC of SD +Ef | 9.029 ± 0.003* | 6.751 ± 0.002* | 25.02 | 0.413 ± 0.003 | 0.072 ± 0.005* | -82.57 | 47.260 ± 0.003 | 48.963± 0.004* | 3.48 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 34. Concentration of lead (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of lead (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 5.560 ± 0.003 | 5.391 ± 0.003 | 3.04 | 1.264 ± 0.003 | 0.845 ± 0.005* | 33.15 | - | - | - |
| Soil+VC of BD+Ef | 5.621 ± 0.003* | 4.125 ± 0.002* | 26.61 | 1.264 ± 0.003 | 0.652 ± 0.004* | 48.42 | 12.849 ± 0.003 | 14.553± 0.003* | 11.71 |
| Soil+VC of CD+Ef | 5.615± 0.004* | 3.857 ± 0.003* | 31.31 | 1.264 ± 0.003 | 0.614 ± 0.003* | 51.42 | 12.849 ± 0.003 | 14.611± 0.004* | 12.06 |
| Soil+VC of GD +Ef | 5.629± 0.002* | 4.167 ± 0.005* | 25.97 | 1.264 ± 0.003 | 0.521 ± 0.003* | 58.78 | 12.849 ± 0.003 | 14.526± 0.003* | 11.54 |
| Soil+VC of HD+Ef | 5.633 ± 0.003* | 4.216 ± 0.003* | 25.16 | 1.264 ± 0.003 | 0.617 ± 0.004* | 51.19 | 12.849 ± 0.003 | 14.534± 0.003* | 11.59 |
| Soil+VC of SD +Ef | 5.618 ± 0.004* | 4.256 ± 0.002* | 24.24 | 1.264 ± 0.003 | 0.635 ± 0.003* | 49.76 | 12.849 ± 0.003 | 14.529± 0.002* | 11.56 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 35. Concentration of nickel (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of nickel (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 1.517 ± 0.004 | 1.284 ± 0.003 | 15.36 | 0.856 ± 0.002 | 0.715 ± 0.008* | 16.47 | - | - | - |
| Soil+VC of BD+Ef | 1.539 ± 0.003* | 1.127 ± 0.003* | 26.77 | 0.856 ± 0.002 | 0.437 ± 0.005* | 48.95 | 3.326 ± 0.002 | 4.408± 0.003* | 24.55 |
| Soil+VC of CD+Ef | 1.528 ± 0.003* | 0.938 ± 0.004* | 38.61 | 0.856 ± 0.002 | 0.412 ± 0.003* | 51.87 | 3.326 ± 0.002 | 4.532± 0.004* | 26.61 |
| Soil+VC of GD +Ef | 1.536 ± 0.002* | 0.911 ± 0.002* | 40.69 | 0.856 ± 0.002 | 0.428 ± 0.002* | 50.00 | 3.326 ± 0.002 | 4.525± 0.002* | 26.50 |
| Soil+VC of HD+Ef | 1.530 ± 0.004* | 0.869 ± 0.005* | 43.20 | 0.856 ± 0.002 | 0.379 ± 0.002* | 55.72 | 3.326 ± 0.002 | 4.528± 0.003* | 26.55 |
| Soil+VC of SD +Ef | 1.532 ± 0.005* | 0.834 ± 0.004* | 45.56 | 0.856 ± 0.002 | 0.425 ± 0.003* | 50.35 | 3.326 ± 0.002 | 4.537± 0.002* | 26.69 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).

*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 36. Concentration of cadmium (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of cadmium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 3.246± 0.013 | 3.025 ± 0.008 | 6.81 | 0.615 ± 0.004 | 0.531± 0.007* | 13.66 | - | - | - |
| Soil+VC of BD+Ef | 3.471 ± 0.022* | 1.394 ± 0.013* | 59.84 | 0.615 ± 0.004 | 0.326 ± 0.003* | 46.99 | 1.882 ± 0.005 | 3.540± 0.012* | 46.84 |
| Soil+VC of CD+Ef | 3.528 ± 0.008* | 1.118 ± 0.005* | 68.31 | 0.615 ± 0.004 | 0.578 ± 0.006* | 6.02 | 1.882 ± 0.005 | 2.416± 0.009* | 22.10 |
| Soil+VC of GD +Ef | 3.326 ± 0.010* | 1.157 ± 0.004* | 65.21 | 0.615 ± 0.004 | 0.430 ± 0.004* | 30.08 | 1.882 ± 0.005 | 2.382± 0.004* | 20.99 |
| Soil+VC of HD+Ef | 3.297 ± 0.015* | 1.316 ± 0.011* | 60.08 | 0.615 ± 0.004 | 0.235 ± 0.003* | 61.79 | 1.882 ± 0.005 | 2.365± 0.012* | 20.42 |
| Soil+VC of SD +Ef | 3.316 ± 0.007* | 1.242 ± 0.014* | 62.55 | 0.615 ± 0.004 | 0.341 ± 0.006* | 44.55 | 1.882 ± 0.005 | 3.362± 0.003* | 44.02 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 37. Concentration of arsenic (mg/kg) in experimental soil, wheat grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of arsenic (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In wheat crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 0.472 ± 0.005 | 0.387 ± 0.012 | 18.01 | 0.268 ± 0.003 | 0.329 ± 0.004* | 18.54 | - | - | - |
| Soil+VC of BD+Ef | 0.546 ± 0.007* | 0.155 ± 0.003* | 71.61 | 0.268 ± 0.003 | 0.177 ± 0.003* | -33.96 | 0.503 ± 0.003 | 1.631± 0.015* | 69.16 |
| Soil+VC of CD+Ef | 0.513 ± 0.008* | 0.126 ± 0.014* | 75.44 | 0.268 ± 0.003 | 0.182 ± 0.012* | -32.09 | 0.503 ± 0.003 | 1.622± 0.002* | 68.99 |
| Soil+VC of GD +Ef | 0.498 ± 0.004* | 0.180 ± 0.011* | 63.86 | 0.268 ± 0.003 | BDL | -100.00 | 0.503 ± 0.003 | 1.627± 0.013* | 69.08 |
| Soil+VC of HD+Ef | 0.422 ± 0.006* | 0.105 ± 0.009* | 75.12 | 0.268 ± 0.003 | BDL | -100.00 | 0.503 ± 0.003 | 1.638± 0.004* | 69.29 |
| Soil+VC of SD +Ef | 0.502 ± 0.003* | 0.179± 0.003* | 64.34 | 0.268 ± 0.003 | 0.145± 0.009* | -45.90 | 0.503 ± 0.003 | 1.630± 0.007* | 69.14 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of wheat crop grain are significant at $P<0.05$ (t-test).

Table 38. Concentration of cobalt (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of cobalt (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 2.864 ± 0.013 | 2.537 ± 0.009 | 11.42 | 0.286± 0.008 | 0.113± 0.007* | 60.49 | - | - | - |
| Soil+VC of BD+Ef | 2.881± 0.008* | 1.614 ± 0.005* | 43.98 | 0.286± 0.008 | 0.043 ± 0.008* | 84.97 | 6.182± 0.009 | 7.721± 0.009* | 19.93 |
| Soil+VC of CD+Ef | 2.895± 0.015* | 1.620 ± 0.011* | 44.04 | 0.286± 0.008 | 0.038 ± 0.004* | 86.71 | 6.182± 0.009 | 8.814± 0.004* | 29.86 |
| Soil+VC of GD +Ef | 2.885 ± 0.012* | 1.618 ± 0.013* | 43.92 | 0.286± 0.008 | BDL | 100.00 | 6.182± 0.009 | 8.730± 0.013* | 29.19 |
| Soil+VC of HD+Ef | 2.890± 0.010* | 1.625 ± 0.016* | 43.77 | 0.286± 0.008 | 0.022 ± 0.012* | 92.31 | 6.182± 0.009 | 9.828± 0.007* | 37.10 |
| Soil+VC of SD +Ef | 2.871± 0.006* | 1.613 ± 0.012* | 43.82 | 0.286± 0.008 | BDL | 100.00 | 6.182± 0.009 | 7.715± 0.005* | 19.87 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

Table 39. Concentration of chromium (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of chromium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 10.298 ± 0.010 | 9.476 ± 0.015 | 7.98 | 1.347 ± 0.005 | 0.852 ± 0.008* | 36.75 | - | - | - |
| Soil+VC of BD+Ef | 10.325 ± 0.014* | 8.559 ± 0.004* | 17.10 | 1.347 ± 0.005 | 0.715 ± 0.014* | 46.92 | 5.913 ± 0.011 | 7.206± 0.008* | 17.94 |
| Soil+VC of CD+Ef | 10.320 ± 0.013* | 8.551 ± 0.009* | 17.14 | 1.347 ± 0.005 | 0.164 ± 0.016* | 87.82 | 5.913 ± 0.011 | 6.172± 0.012* | 4.20 |
| Soil+VC of GD +Ef | 10.315 ± 0.008* | 8.553± 0.012* | 17.08 | 1.347 ± 0.005 | 0.150 ± 0.007* | 88.86 | 5.913 ± 0.011 | 6.855± 0.014* | 13.74 |
| Soil+VC of HD+Ef | 10.324 ± 0.005* | 8.548 ± 0.008* | 17.20 | 1.347 ± 0.005 | 0.103 ± 0.006* | 92.35 | 5.913 ± 0.011 | 7.191± 0.006* | 17.77 |
| Soil+VC of SD +Ef | 10.316 ± 0.013* | 8.550 ± 0.011* | 17.12 | 1.347 ± 0.005 | 0.115 ± 0.011* | 91.46 | 5.913 ± 0.011 | 6.185± 0.009* | 4.40 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

Table 40. Concentration of lead (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*

| Particulars | Concentration of lead (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 4.948 ± 0.004 | 4.629 ± 0.013 | 6.45 | 0.245 ± 0.011 | 0.392 ± 0.006* | 37.50 | - | - | - |
| Soil+VC of BD+Ef | 5.143 ± 0.009* | 3.538 ± 0.011* | 31.21 | 0.245 ± 0.011 | 0.038 ± 0.005* | -84.49 | 8.067 ± 0.005 | 11.547± 0.013* | 30.14 |
| Soil+VC of CD+Ef | 5.016 ± 0.004* | 3.463 ± 0.006* | 30.96 | 0.245 ± 0.011 | 0.061 ± 0.008* | -75.10 | 8.067 ± 0.005 | 10.218± 0.004* | 21.05 |
| Soil+VC of GD +Ef | 4.966 ± 0.012* | 3.341 ± 0.008* | 32.72 | 0.245 ± 0.011 | 0.025 ± 0.006* | -89.80 | 8.067 ± 0.005 | 9.173± 0.008* | 12.06 |
| Soil+VC of HD+Ef | 4.961 ± 0.006* | 3.356 ± 0.013* | 32.35 | 0.245 ± 0.011 | 0.037 ± 0.012* | -84.90 | 8.067 ± 0.005 | 9.290± 0.005* | 13.16 |
| Soil+VC of SD +Ef | 4.973 ± 0.009* | 3.364 ± 0.005* | 32.35 | 0.245 ± 0.011 | 0.050 ± 0.010* | -79.59 | 8.067 ± 0.005 | 9.230± 0.009* | 12.60 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

Table 41. Concentration of nickel (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of nickel (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 5.482 ± 0.003 | 5.197 ± 0.014 | 5.20 | 0.613 ± 0.009 | 0.502 ± 0.016* | 18.11 | - | - | - |
| Soil+VC of BD+Ef | 5.635 ± 0.002* | 3.328 ± 0.015* | 40.94 | 0.613 ± 0.009 | 0.213 ± 0.013* | 65.25 | 10.237 ± 0.018 | 12.351± 0.012* | 17.12 |
| Soil+VC of CD+Ef | 5.619 ± 0.003* | 3.312 ± 0.014* | 41.06 | 0.613 ± 0.009 | 0.454 ± 0.014* | 25.94 | 10.237 ± 0.018 | 12.295± 0.013* | 16.74 |
| Soil+VC of GD +Ef | 5.625 ± 0.005* | 3.322 ± 0.012* | 40.94 | 0.613 ± 0.009 | 0.238 ± 0.017* | 61.17 | 10.237 ± 0.018 | 11.318± 0.017* | 9.55 |
| Soil+VC of HD+Ef | 5.622 ± 0.002* | 3.318 ± 0.016* | 40.98 | 0.613 ± 0.009 | 0.233 ± 0.015* | 61.99 | 10.237 ± 0.018 | 11.162± 0.012* | 8.29 |
| Soil+VC of SD +Ef | 5.614 ± 0.003* | 3.321 ± 0.010* | 40.84 | 0.613 ± 0.009 | 0.245 ± 0.018* | 60.03 | 10.237 ± 0.018 | 11.249± 0.019* | 9.00 |

VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida*

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

Table 42. Concentration of cadmium (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of cadmium (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % change | Before sowing | After harvesting | % increase |
| Soil control | 2.845 ± 0.022 | 2.634 ± 0.014 | 7.42 | 0.267 ± 0.019 | 0.295± 0.011* | 9.49 | - | - | - |
| Soil+VC of BD+Ef | 2.875 ± 0.015* | 1.592 ± 0.020* | 44.63 | 0.267 ± 0.019 | 0.102 ± 0.009* | -61.80 | 2.264 ± 0.017 | 3.140± 0.022* | 27.90 |
| Soil+VC of CD+Ef | 2.863 ± 0.014* | 1.588 ± 0.009* | 44.53 | 0.267 ± 0.019 | 0.014 ± 0.024* | -94.76 | 2.264 ± 0.017 | 4.269± 0.014* | 46.97 |
| Soil+VC of GD +Ef | 2.860 ± 0.009* | 1.463 ± 0.016* | 48.85 | 0.267 ± 0.019 | 0.039 ± 0.008* | -85.39 | 2.264 ± 0.017 | 3.312± 0.013* | 31.64 |
| Soil+VC of HD+Ef | 2.858 ± 0.015* | 1.469 ± 0.013* | 48.60 | 0.267 ± 0.019 | 0.081 ± 0.012* | -69.66 | 2.264 ± 0.017 | 3.851± 0.009* | 41.21 |
| Soil+VC of SD +Ef | 2.865 ± 0.011* | 1.426 ± 0.009* | 50.23 | 0.267 ± 0.019 | 0.106 ± 0.009* | -60.30 | 2.264 ± 0.017 | 3.245± 0.013* | 30.23 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

Table 43. Concentration of arsenic (mg/kg) in experimental soil, rice grain and earthworm body before sowing and after harvesting the crop (wheat) when the soil was mixed with vermicompost of different animal dungs and inoculated with earthworm *Eisenia foetida*.

| Particulars | Concentration of arsenic (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | In experimental soil | | | In rice crop grains | | | In earthworm body | | |
| | Before sowing | After harvesting | % decrease | Before Sowing | After harvesting | % decrease | Before sowing | After harvesting | % increase |
| Soil control | 1.094 ± 0.023 | 0.749 ± 0.015 | 31.54 | 0.070 ± 0.016 | 0.055 ± 0.010* | 21.43 | - | - | - |
| Soil+VC of BD+Ef | 1.165 ± 0.012* | 0.648 ± 0.009* | 44.38 | 0.070 ± 0.016 | 0.032 ± 0.007* | 54.29 | 1.091 ± 0.023 | 3.284± 0.012* | 66.78 |
| Soil+VC of CD+Ef | 1.144 ± 0.026* | 0.641 ± 0.011* | 43.97 | 0.070 ± 0.016 | 0.024 ± 0.005* | 65.71 | 1.091 ± 0.023 | 2.271± 0.020* | 51.96 |
| Soil+VC of GD +Ef | 1.148 ± 0.015* | 0.637 ± 0.024* | 44.51 | 0.070 ± 0.016 | 0.021 ± 0.009* | 70.00 | 1.091 ± 0.023 | 2.280± 0.015* | 52.15 |
| Soil+VC of HD+Ef | 1.131 ± 0.014* | 0.645 ± 0.010* | 42.97 | 0.070 ± 0.016 | 0.044 ± 0.015* | 37.14 | 1.091 ± 0.023 | 3.263± 0.013* | 66.56 |
| Soil+VC of SD +Ef | 1.149 ± 0.013* | 0.638 ± 0.008* | 44.47 | 0.070 ± 0.016 | 0.025 ± 0.018* | 64.29 | 1.091 ± 0.023 | 2.268± 0.017* | 51.90 |
| VC = vermicompost, BD = buffalo dung, CD = cow dung, GD =goat dung, HD = horse dung, SD = sheep dung, Ef = earthworm *Eisenia foetida* | | | | | | | | | |

Values are expressed as Mean ± SD (six replicates).
*Differences between mean values of concentration of heavy metals the soil, soil with different animal dungs vermicompost, earthworm body as well as before sowing and after harvesting of rice crop grain are significant at $P<0.05$ (t-test).

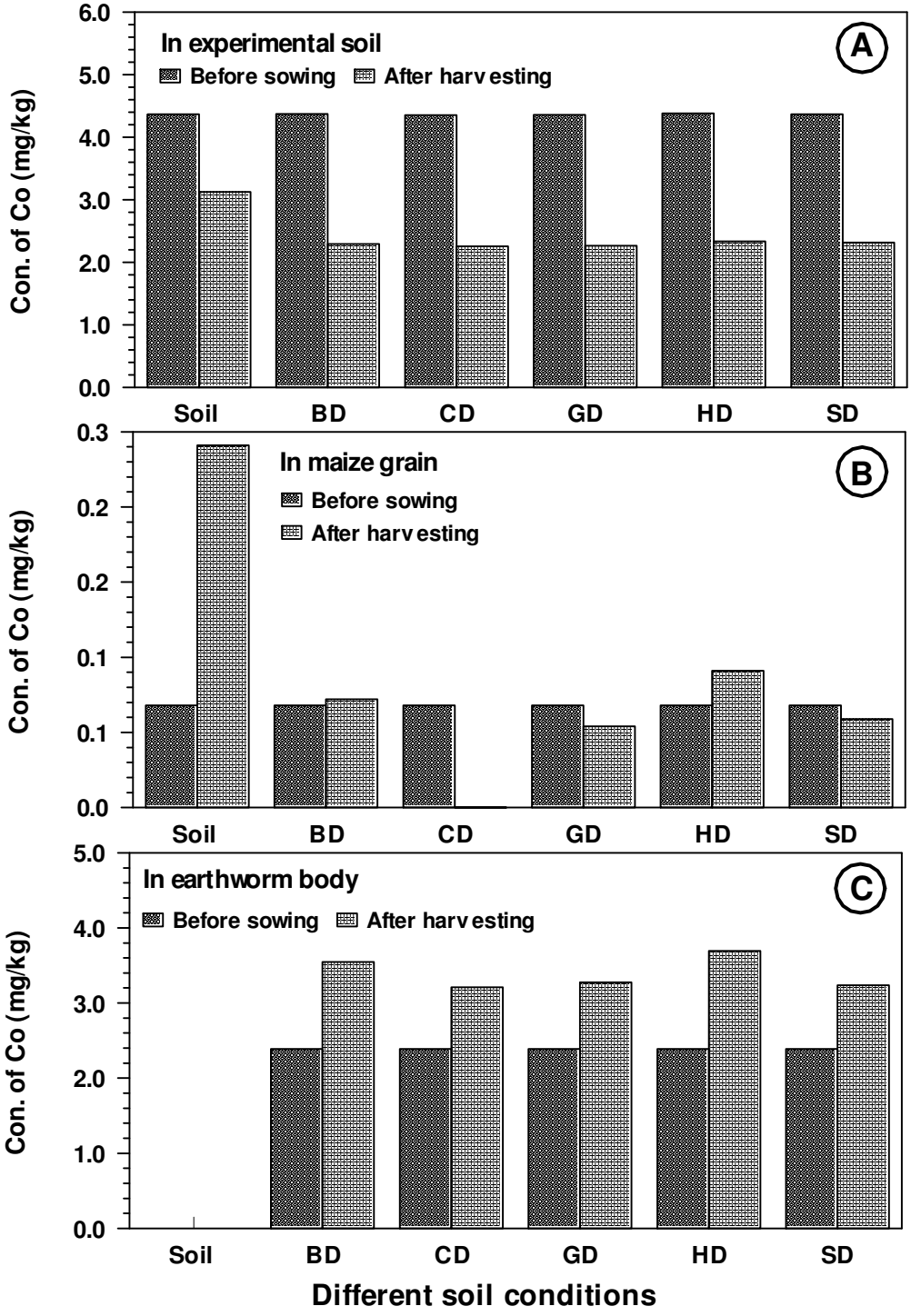



Figure 25. Concentration of cobalt (mg/kg) in experimental soil (A), maize grain (B) and earthworm body (C) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

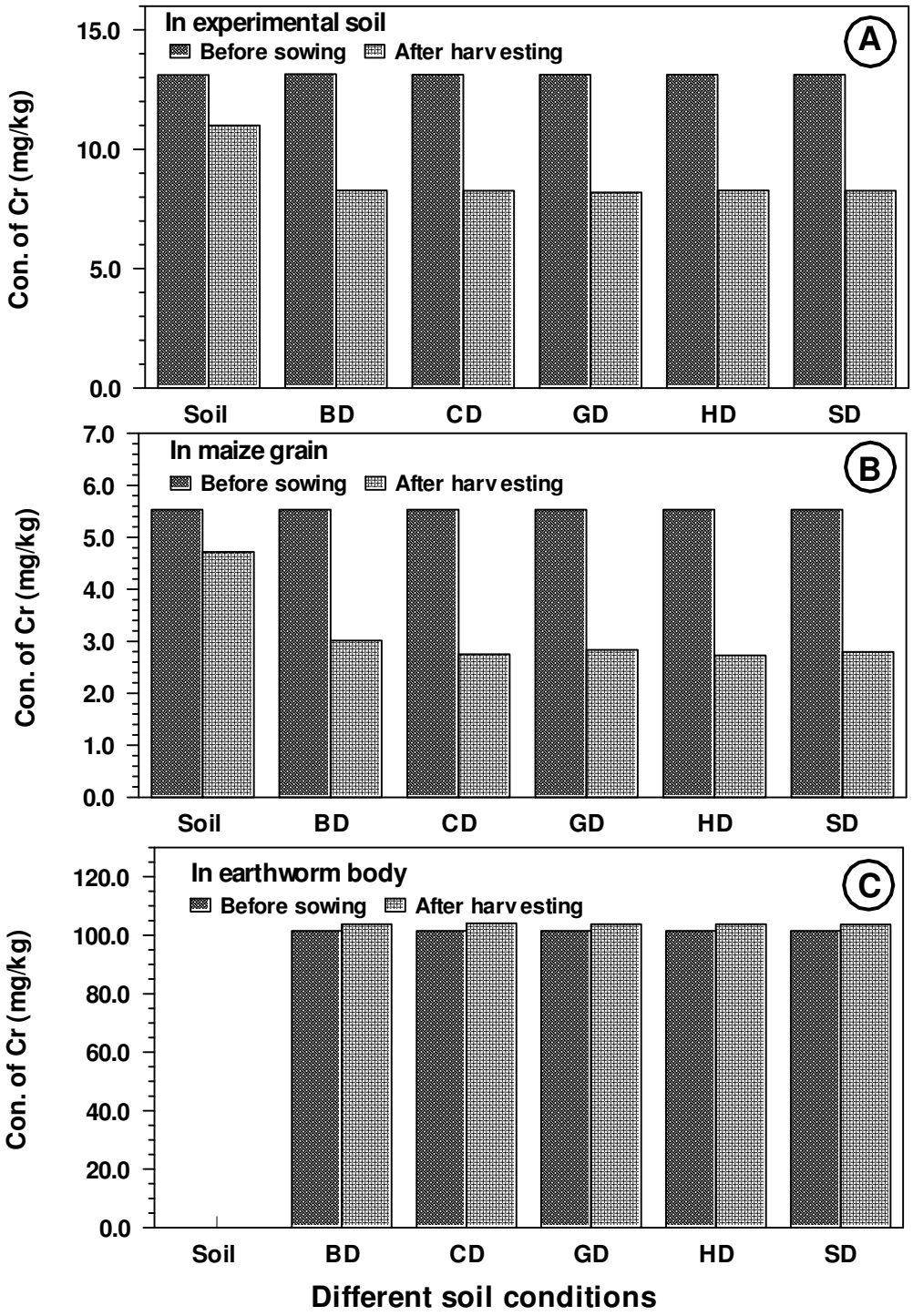



Figure 26. Concentration of chromium (mg/kg) in experimental soil (A), maize grain (B) and earthworm body (C) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

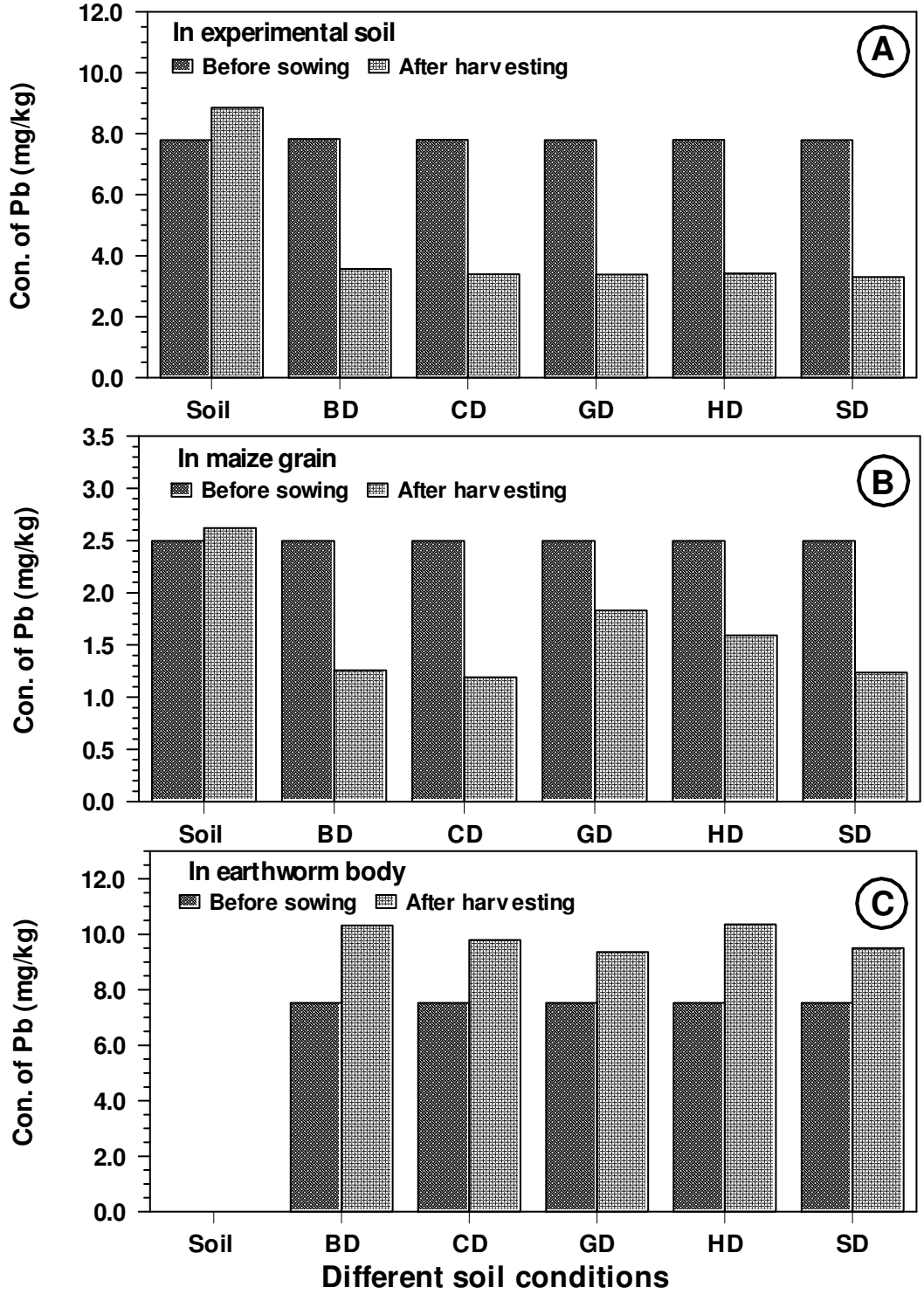



Figure 27. Concentration of lead (mg/kg) in experimental soil (A), maize grain (B) and earthworm body (C) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

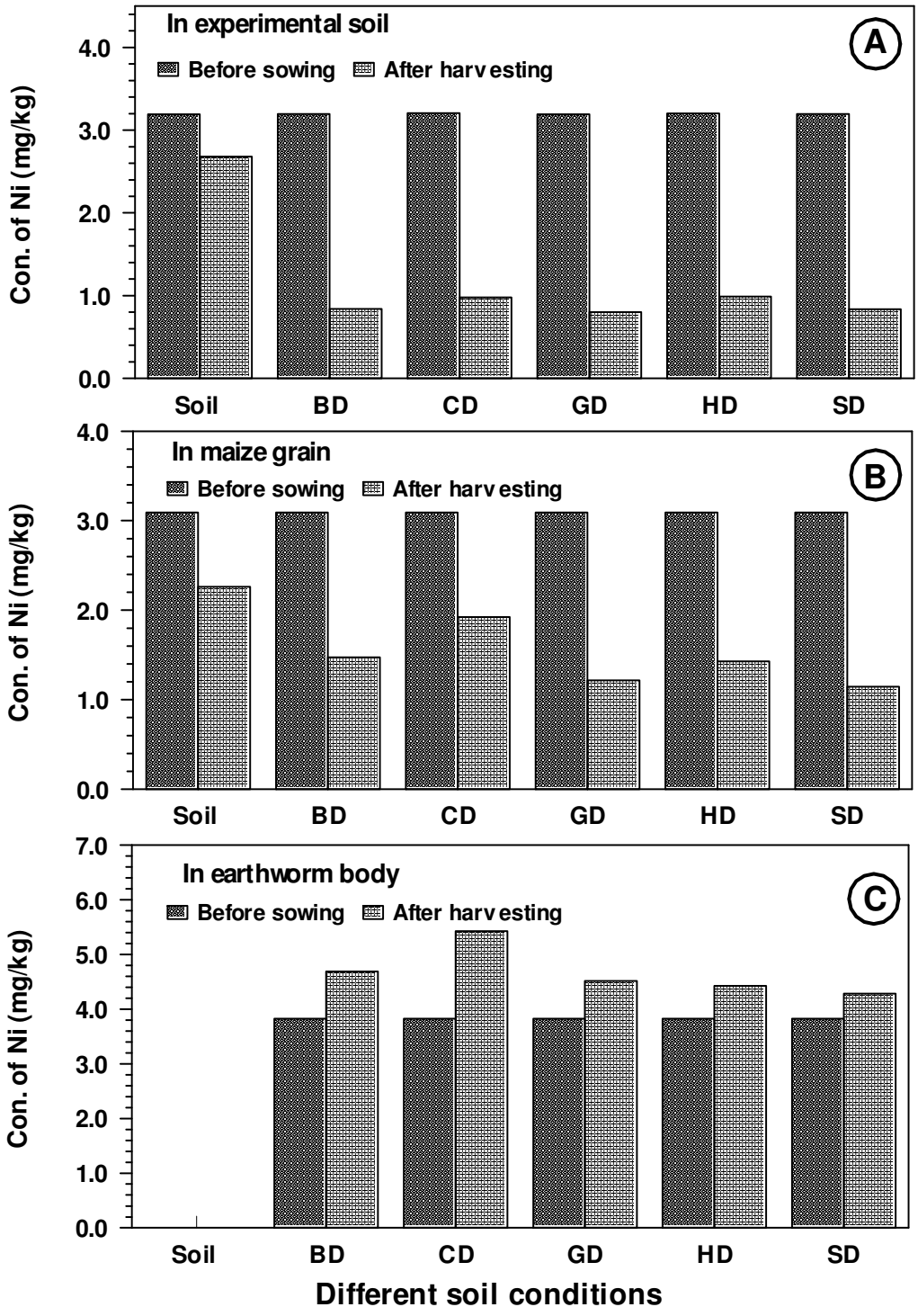
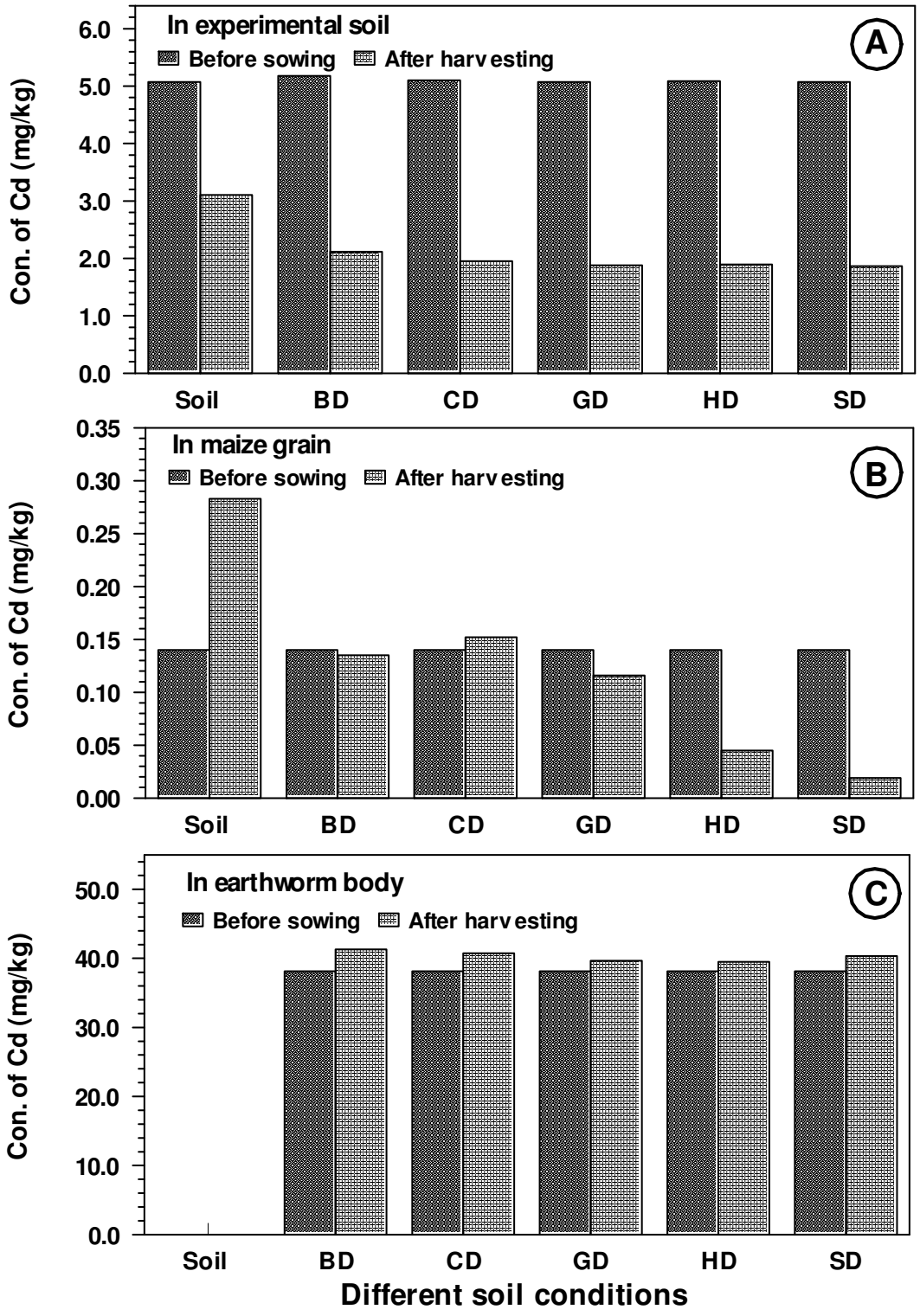



Figure 28. Concentration of nickel (mg/kg) in experimental soil (A), maize grain (B) and earthworm body (C) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.




igure 29. Concentration of cadmium (mg/kg) in experimental soil (A), maize grain (B) and earthworm body (C) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

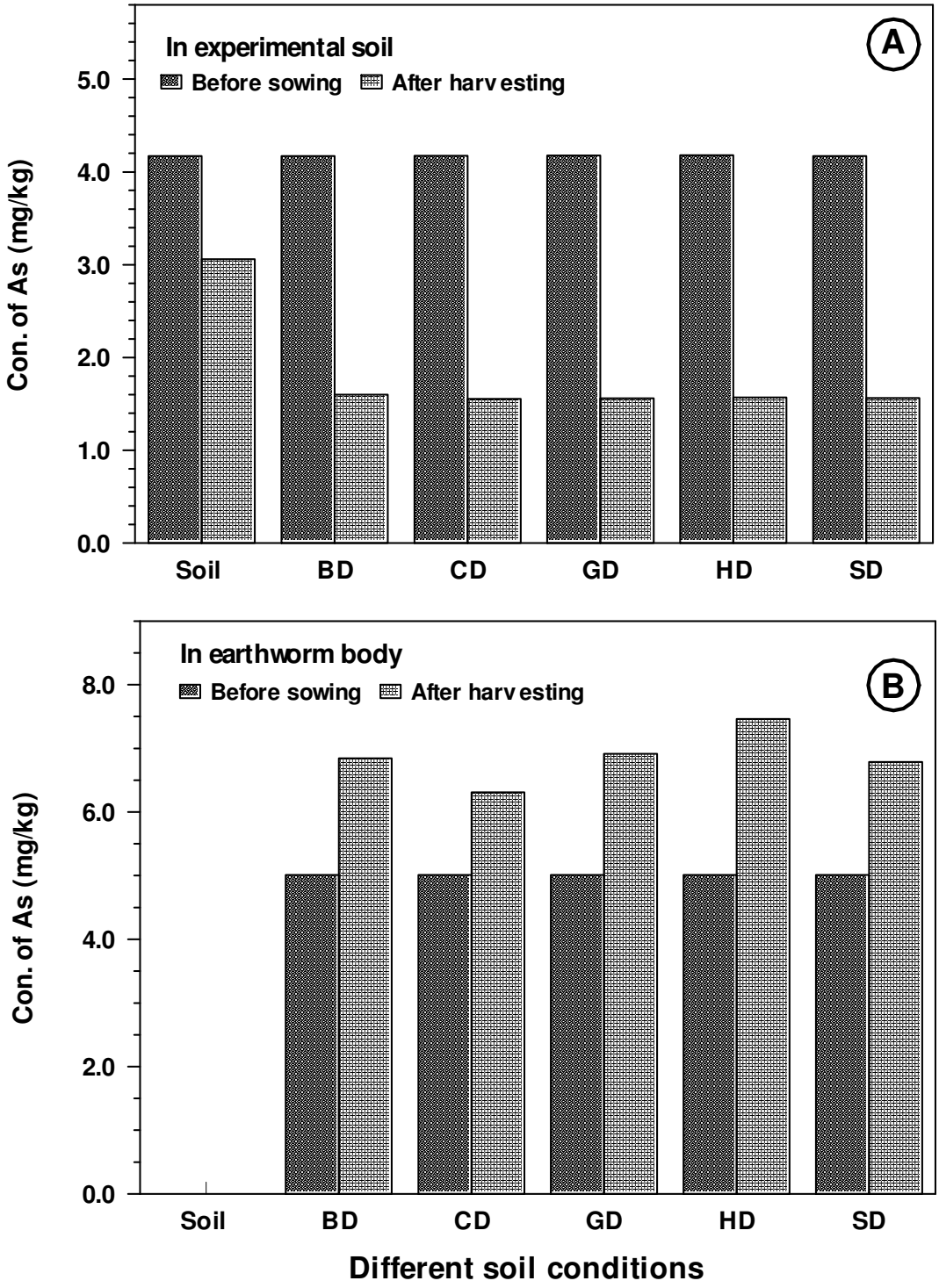



Figure 30. Concentration of arsenic (mg/kg) in experimental soil (A) and earthworm body (B) before sowing and after harvesting the crop (maize) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*. In maize grain no detectable amount of cadmium was observed.

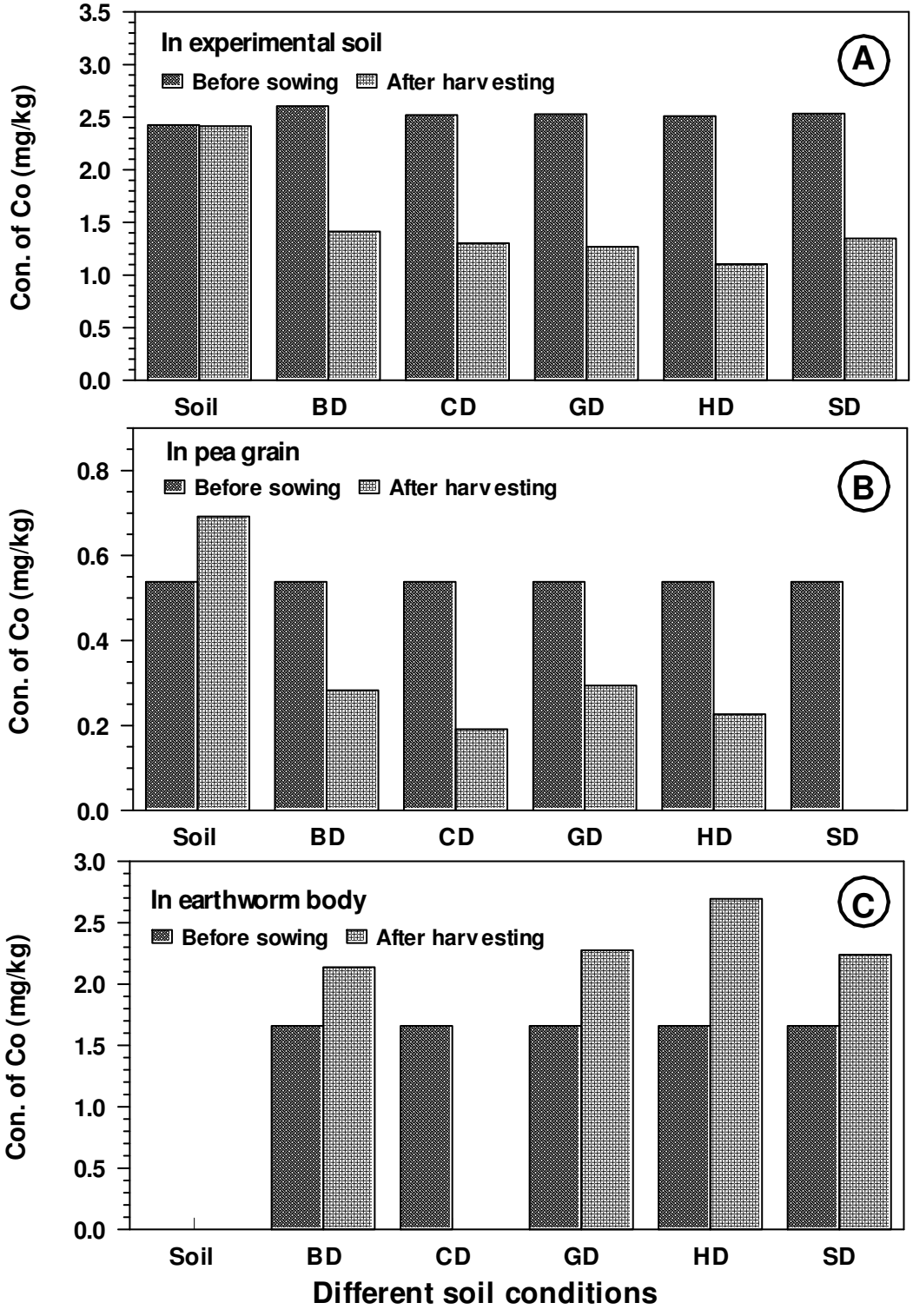



Figure 31. Concentration of cobalt (mg/kg) in experimental soil (A), pea grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

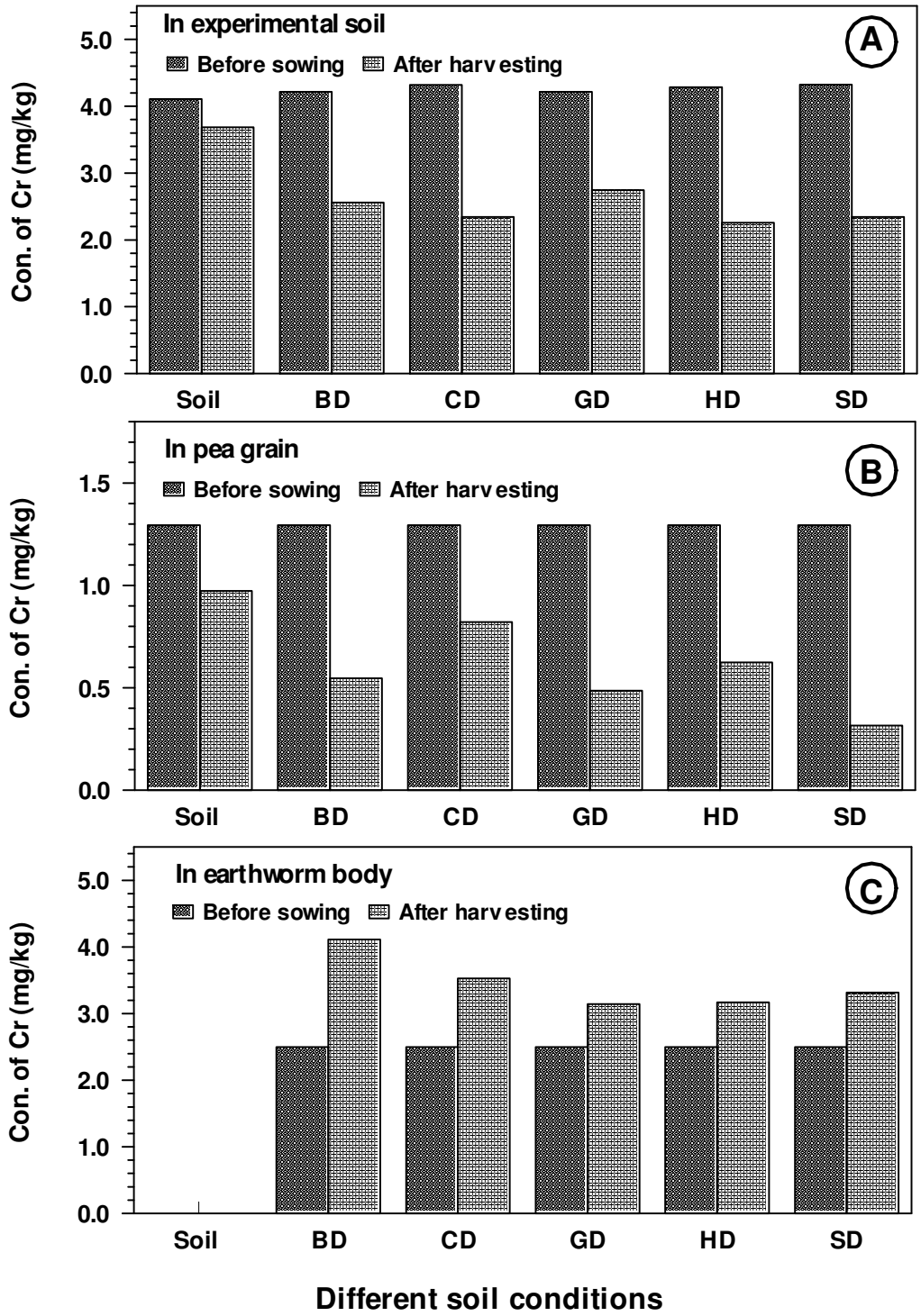



Figure 32. Concentration of chromium (mg/kg) in experimental soil (A), pea grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

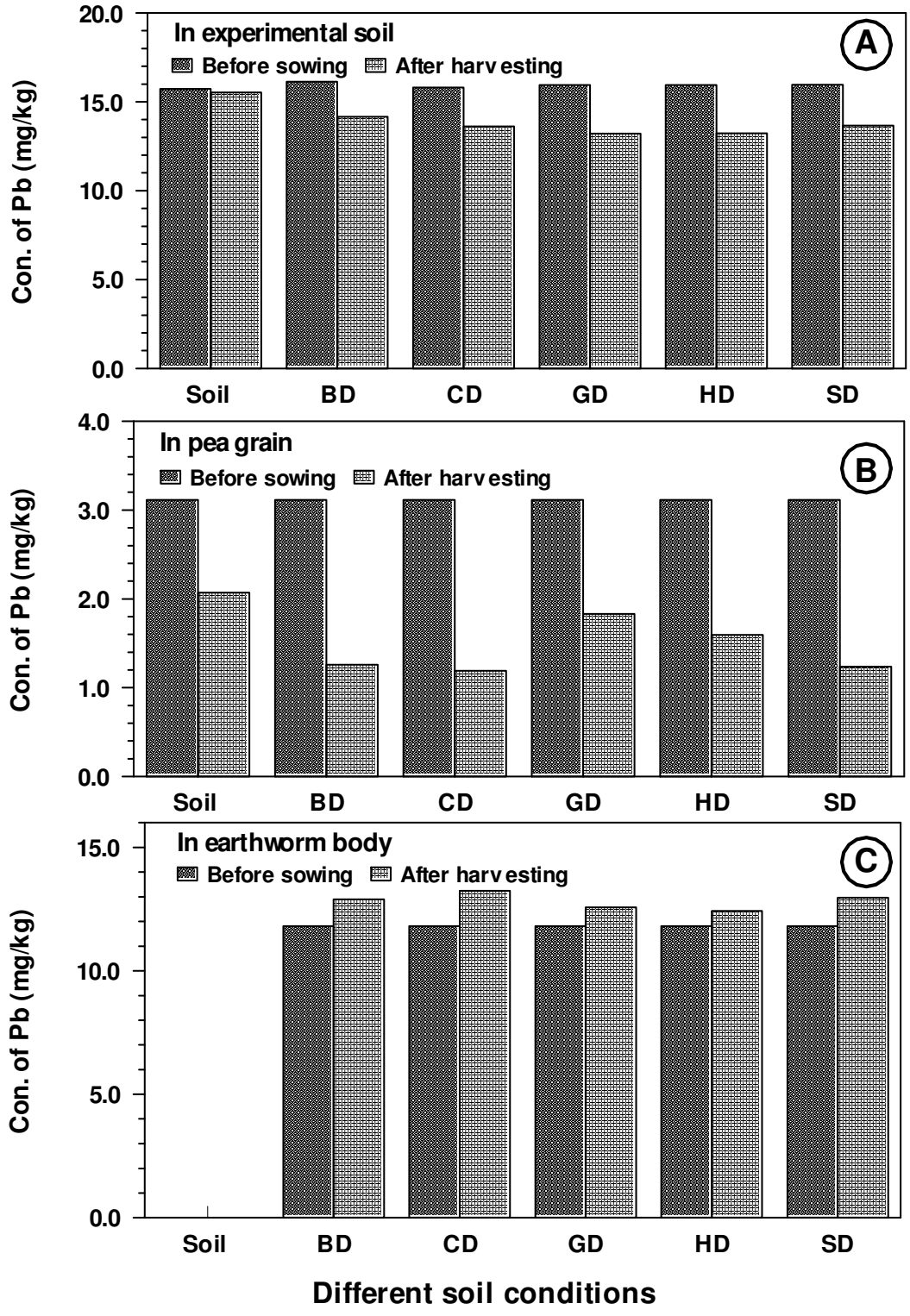



Figure 33. Concentration of lead (mg/kg) in experimental soil (A), peagrain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

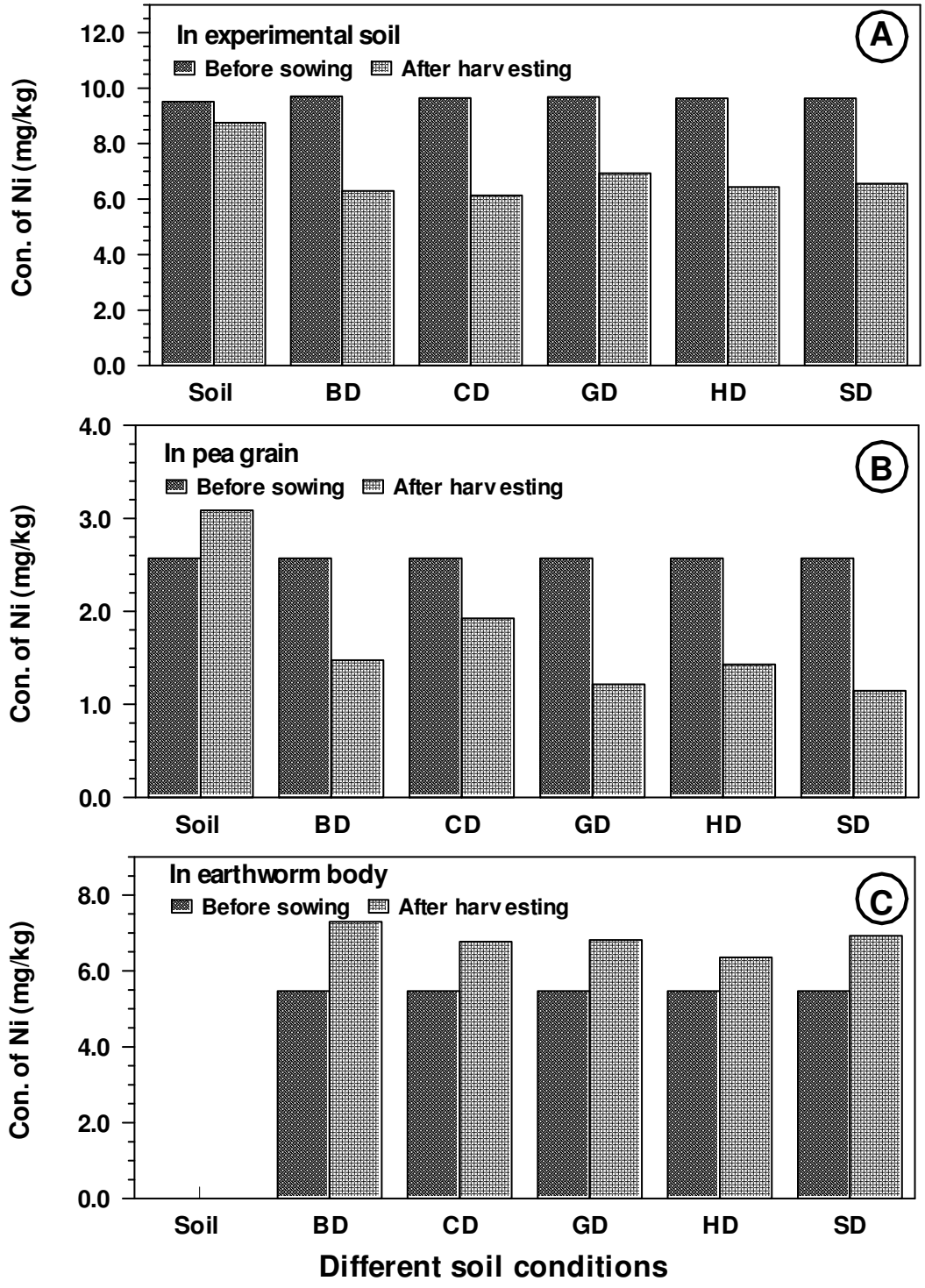



Figure 34. Concentration of nickel (mg/kg) in experimental soil (A), pea grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

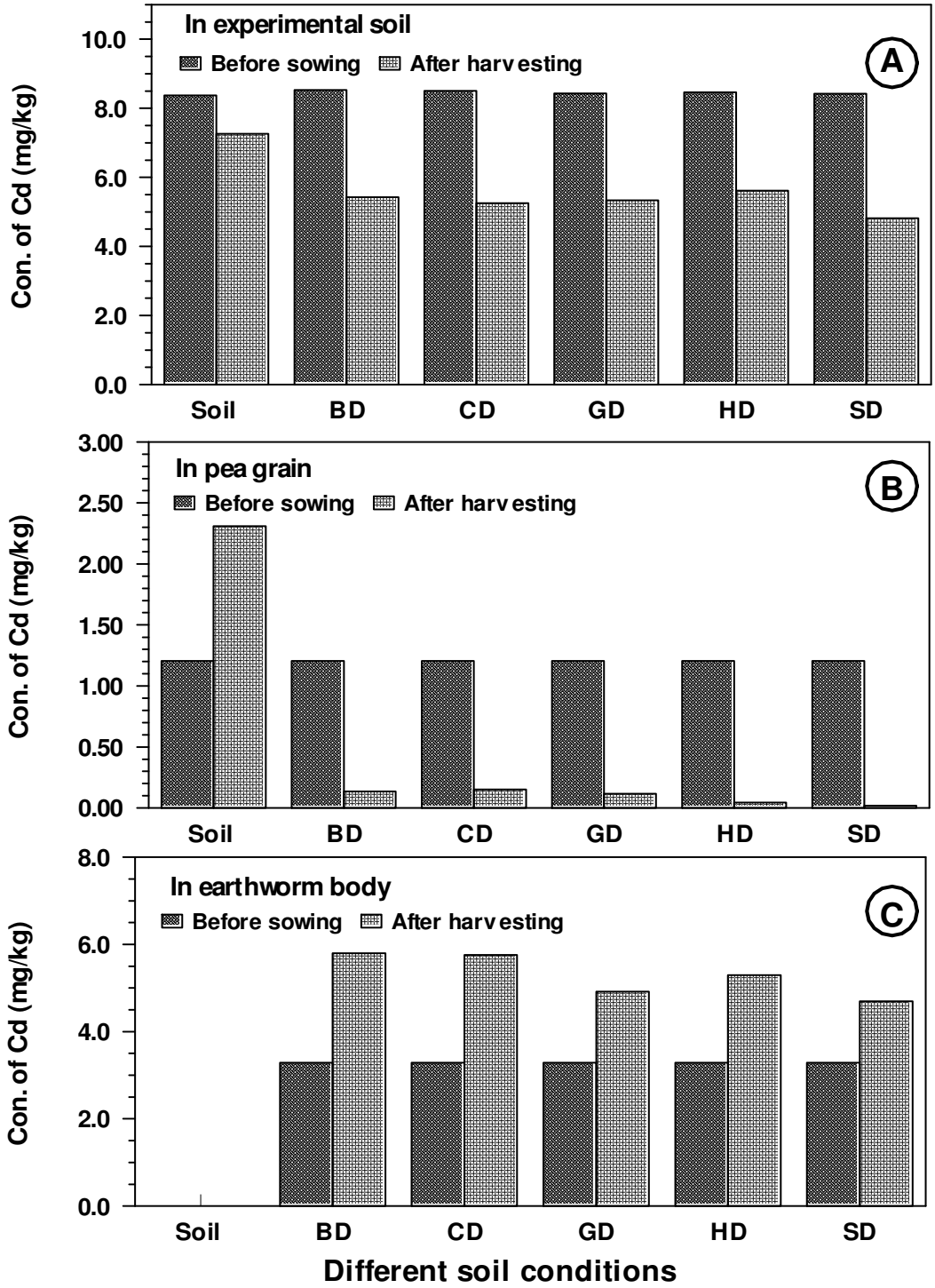



Figure 35. Concentration of cadmium (mg/kg) in experimental soil (A), pea grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

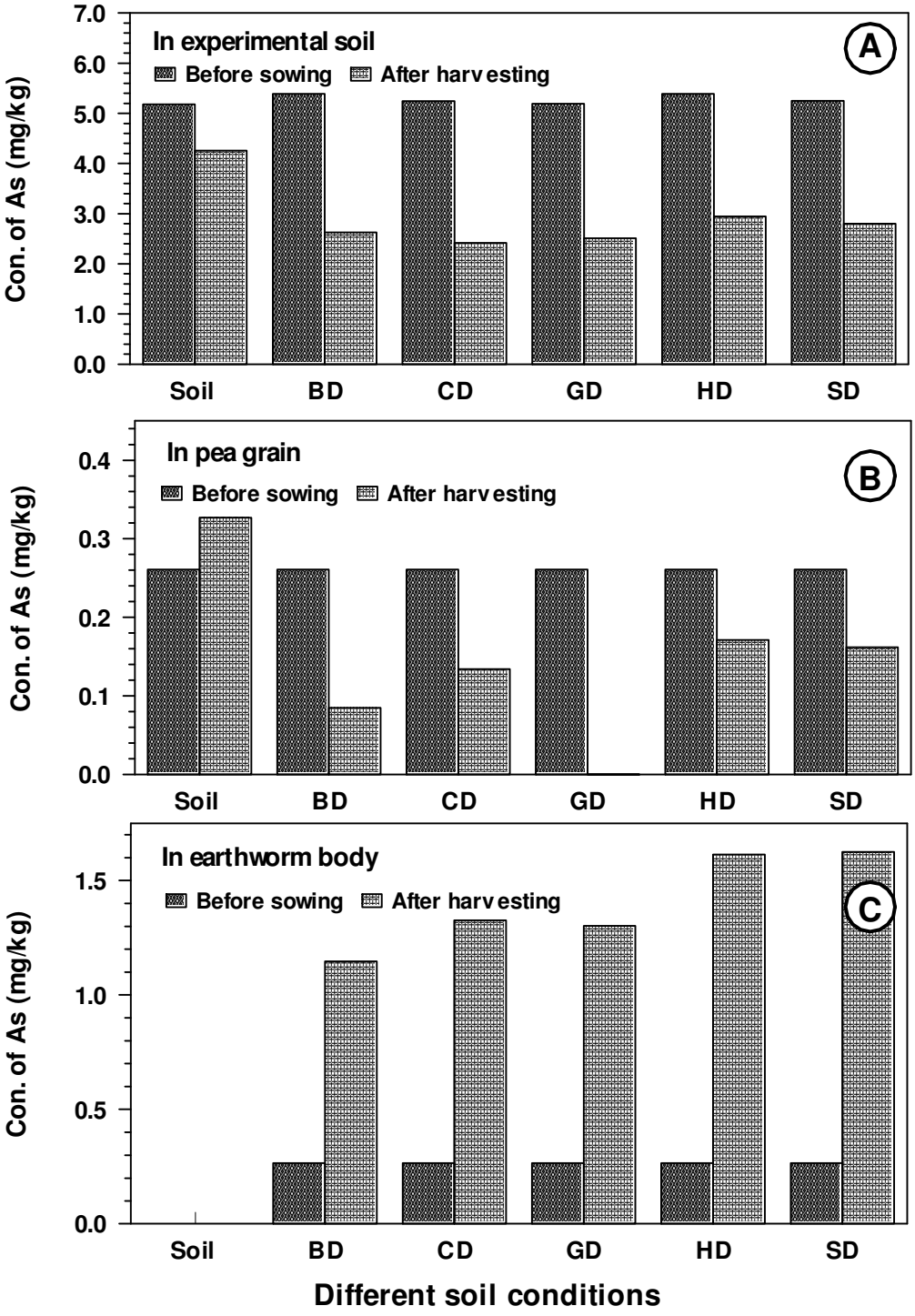



Figure 36. Concentration of arsenic (mg/kg) in experimental soil (A), pea grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

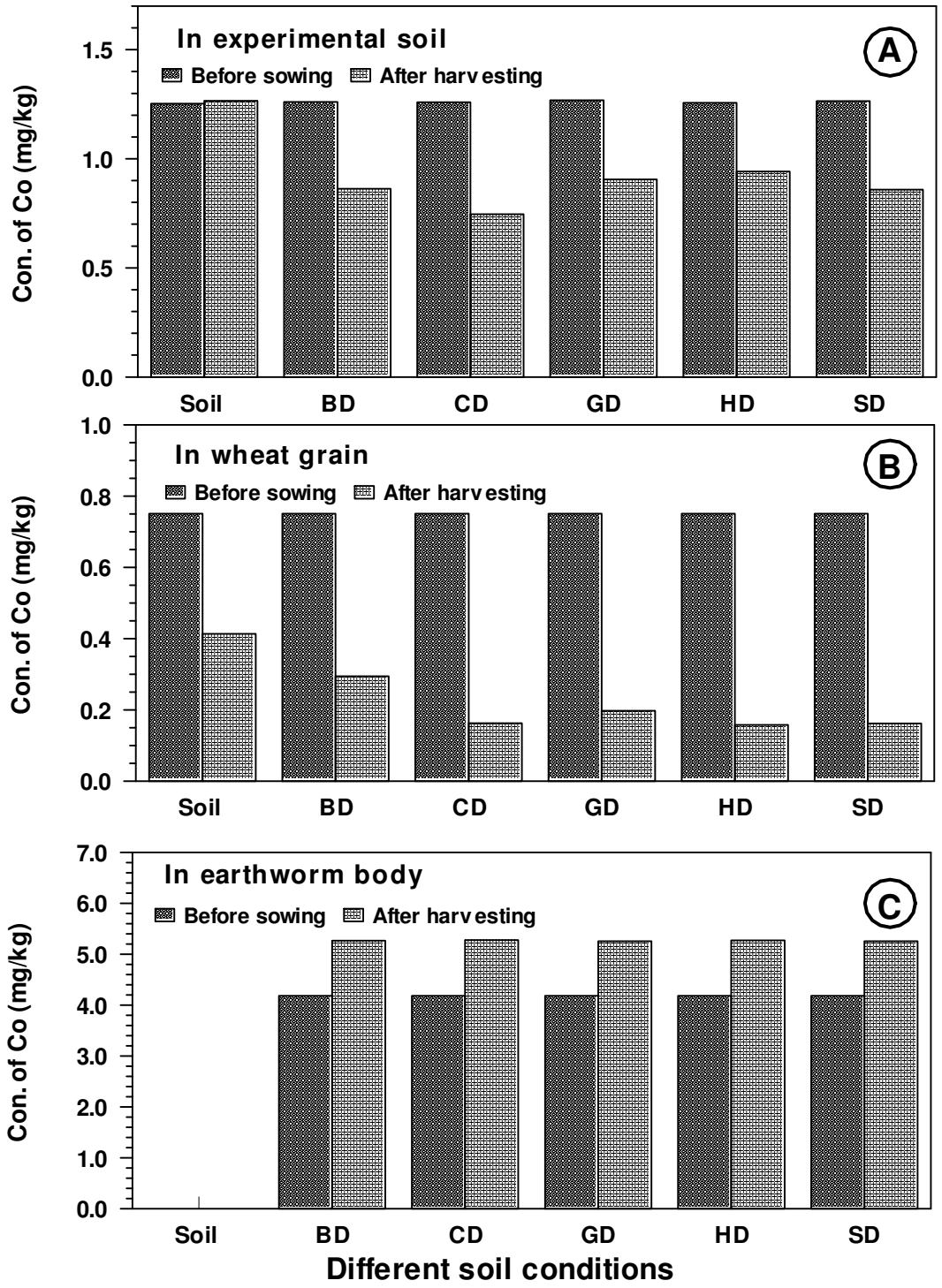



Figure 37. Concentration of cobalt (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

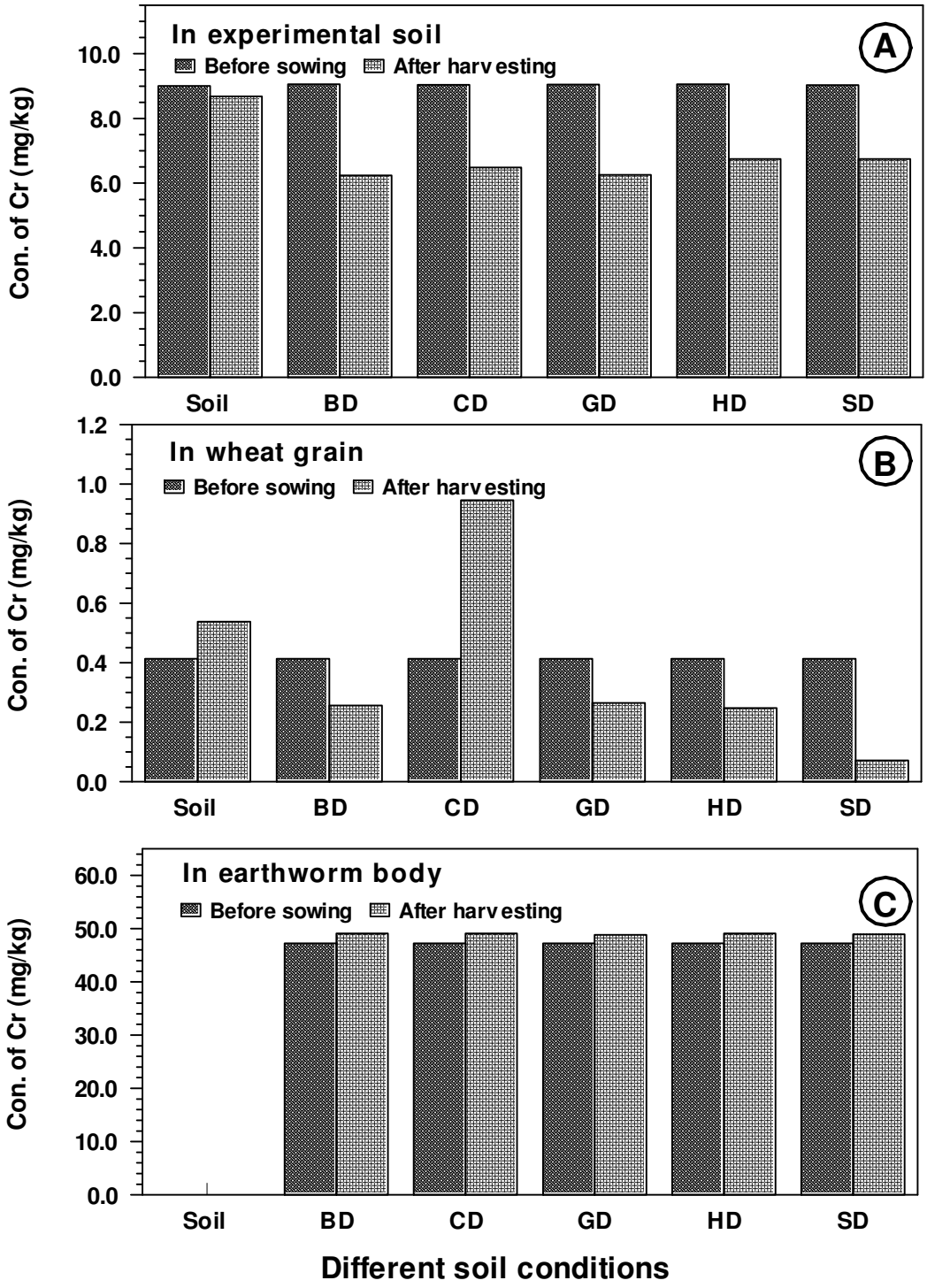



Figure 38. Concentration of chromium (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

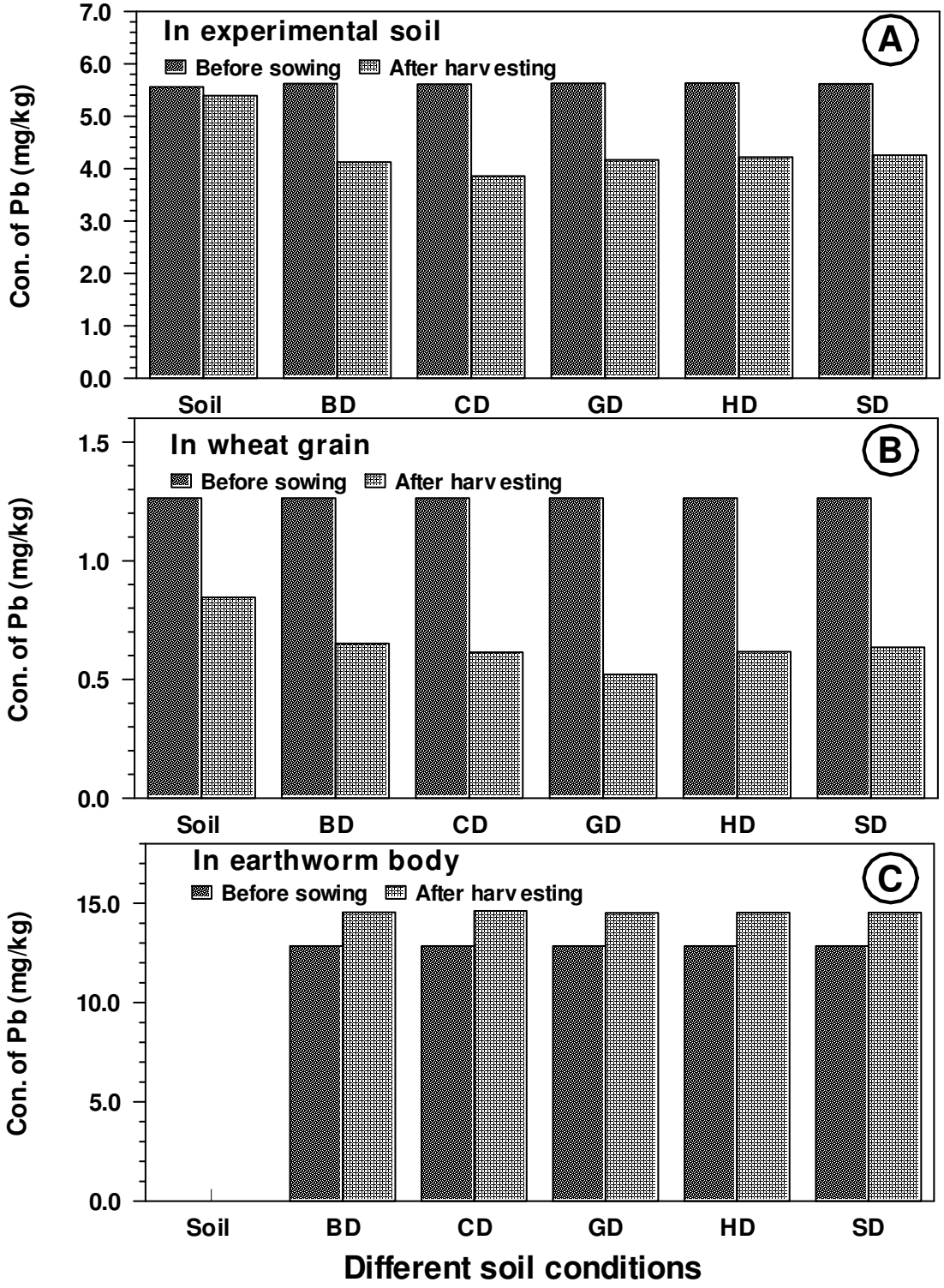



Figure 39. Concentration of lead (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

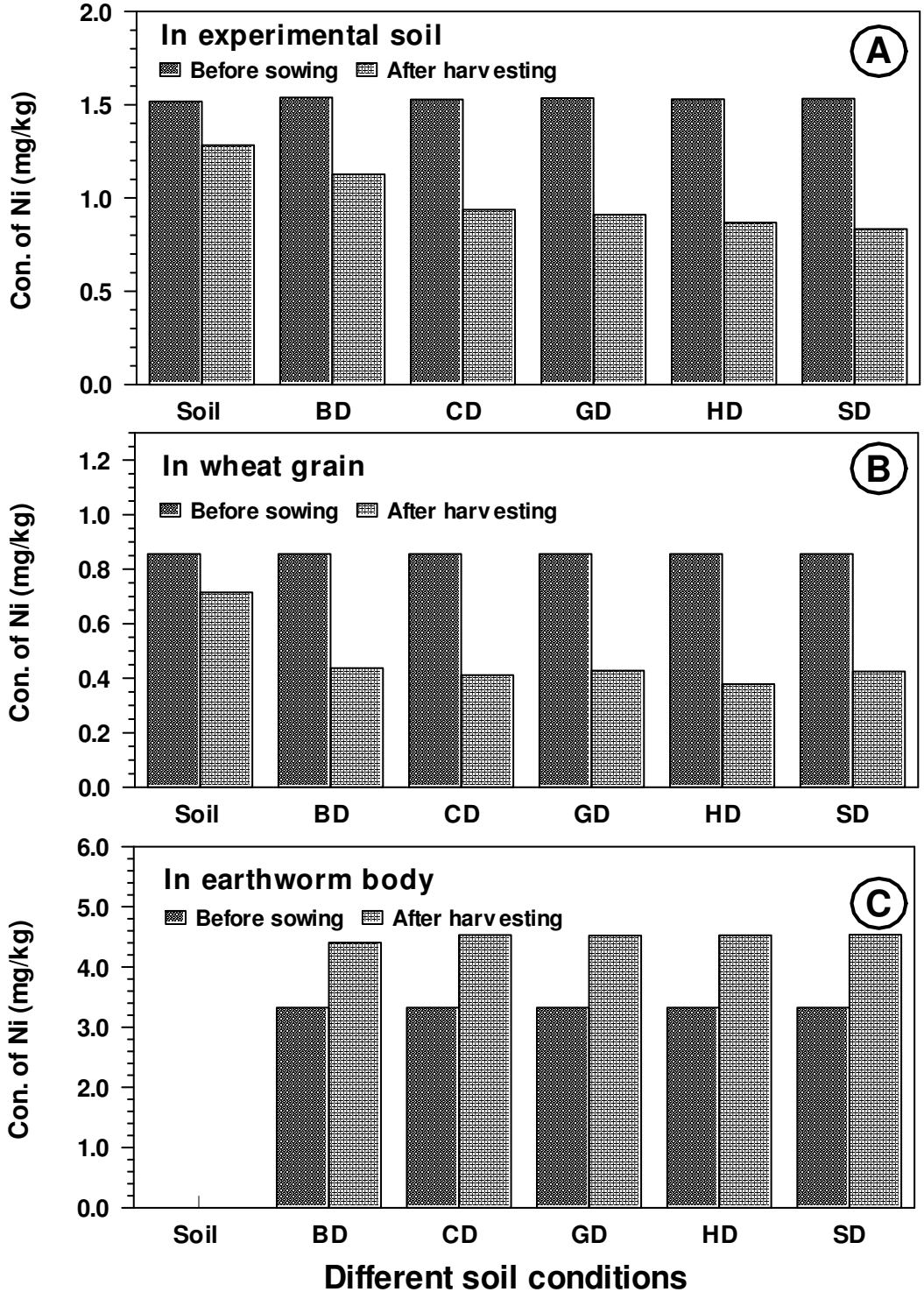



Figure 40. Concentration of nickel (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

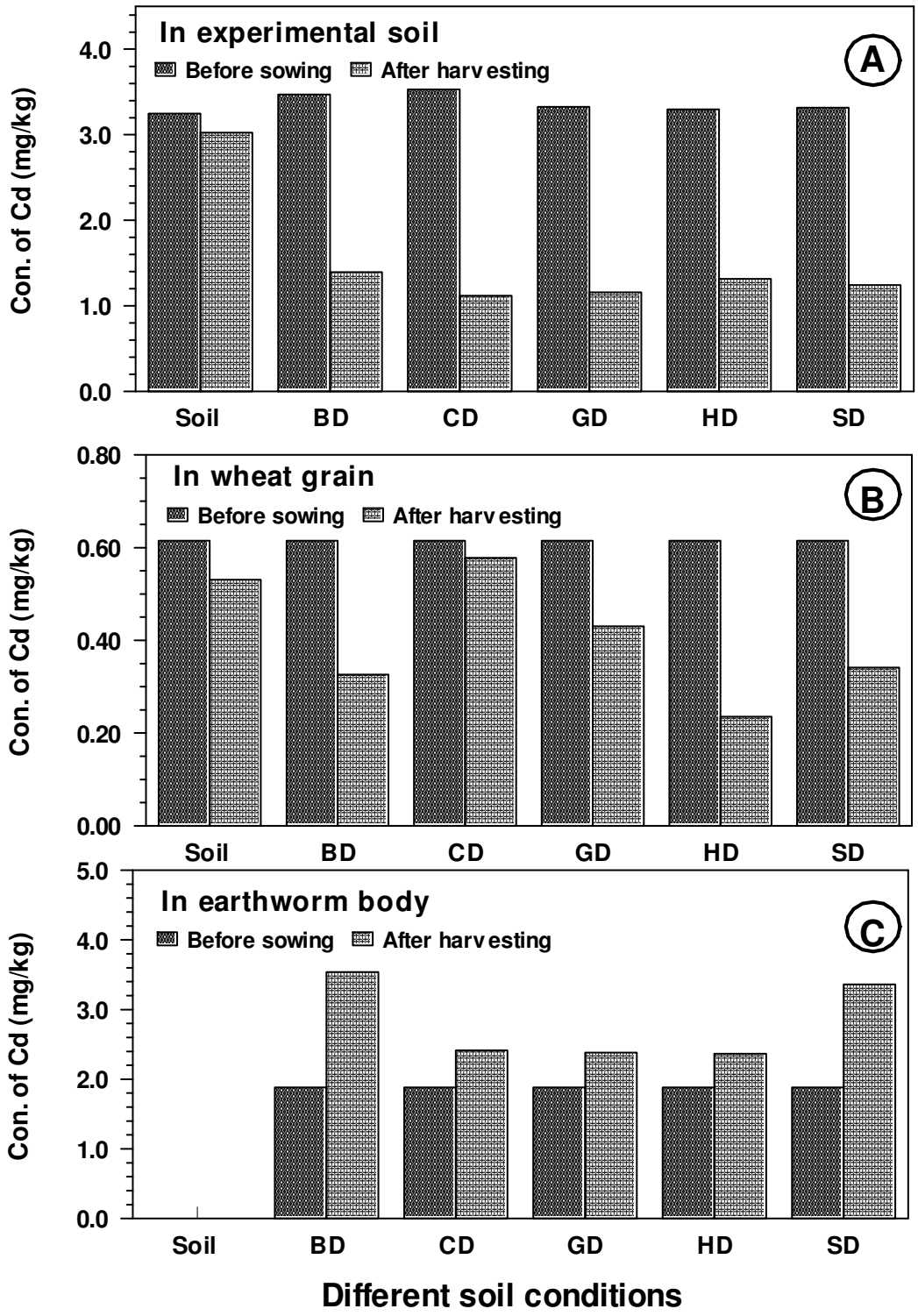



Figure 41. Concentration of cadmium (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

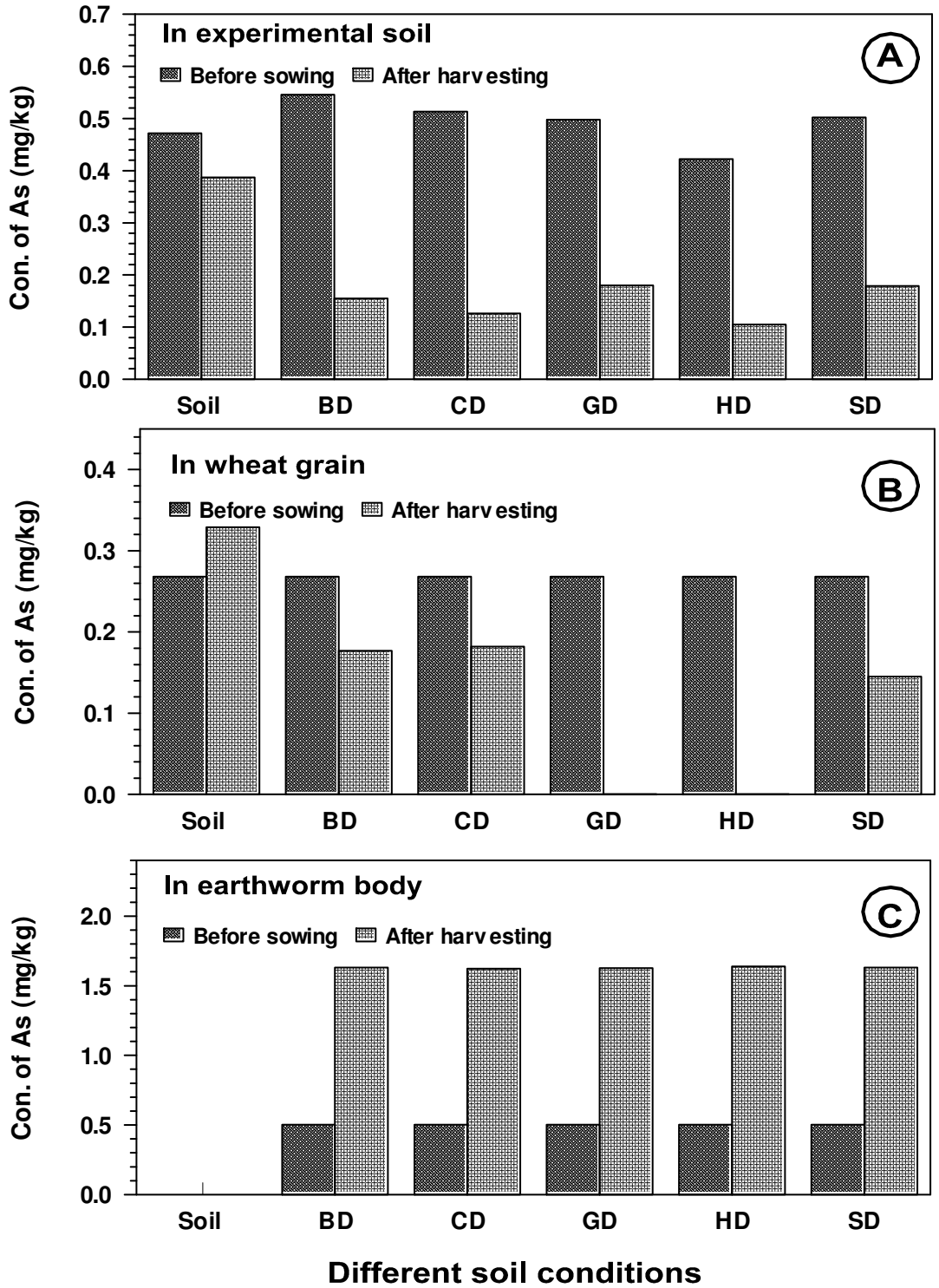



Figure 42. Concentration of arsenic (mg/kg) in experimental soil (A), wheat grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

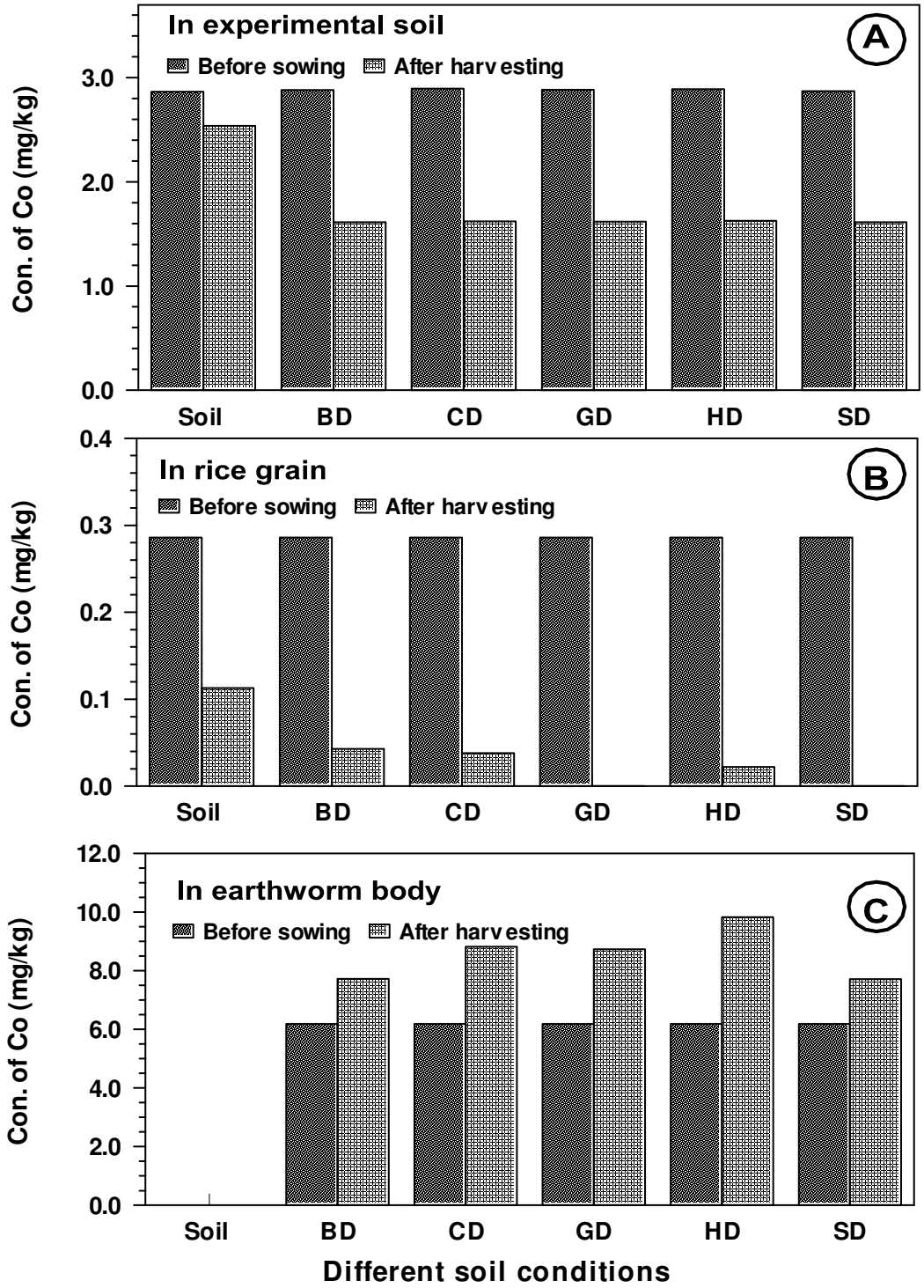



Figure 43. Concentration of cobalt (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

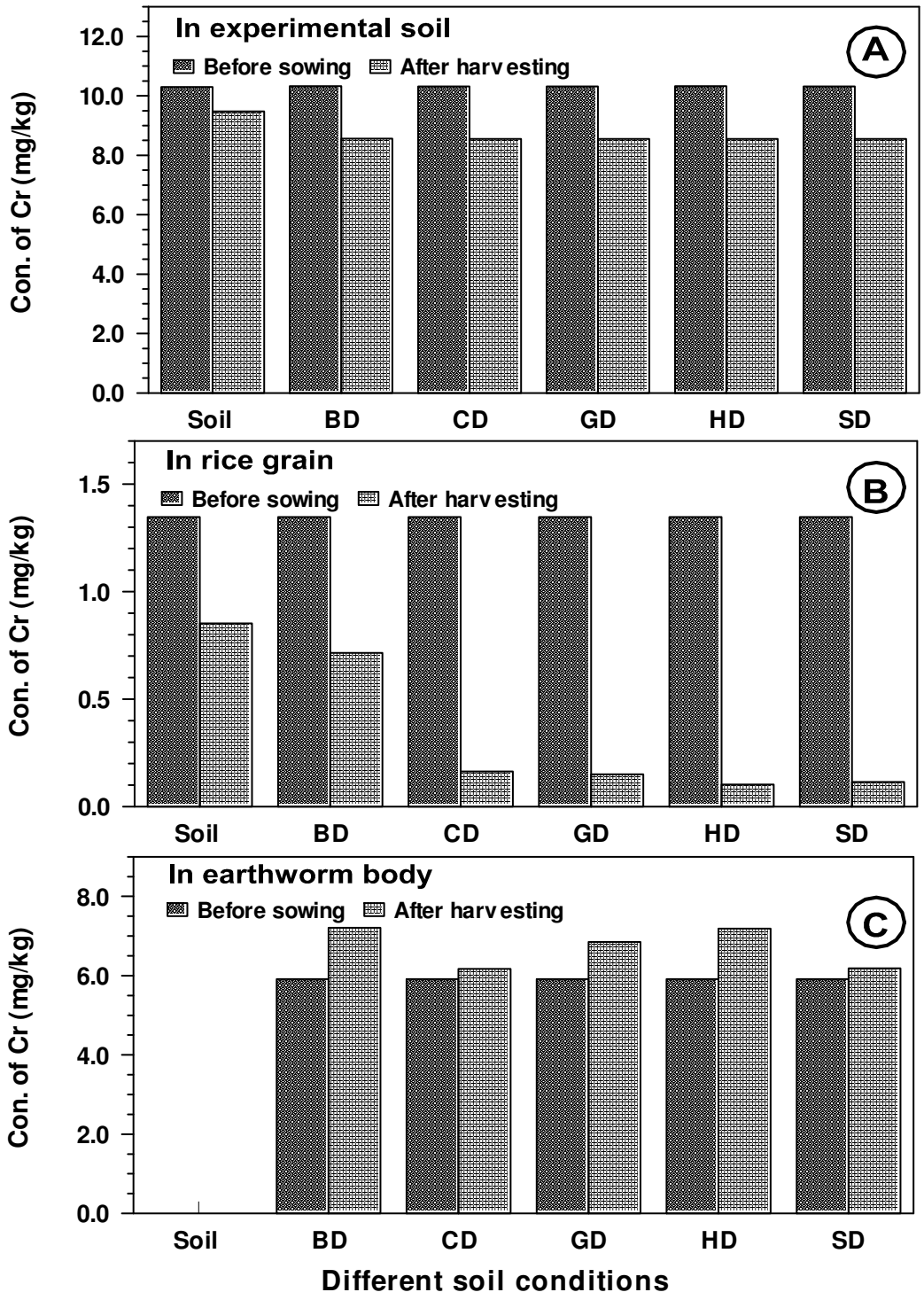



Figure 44. Concentration of chromium (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

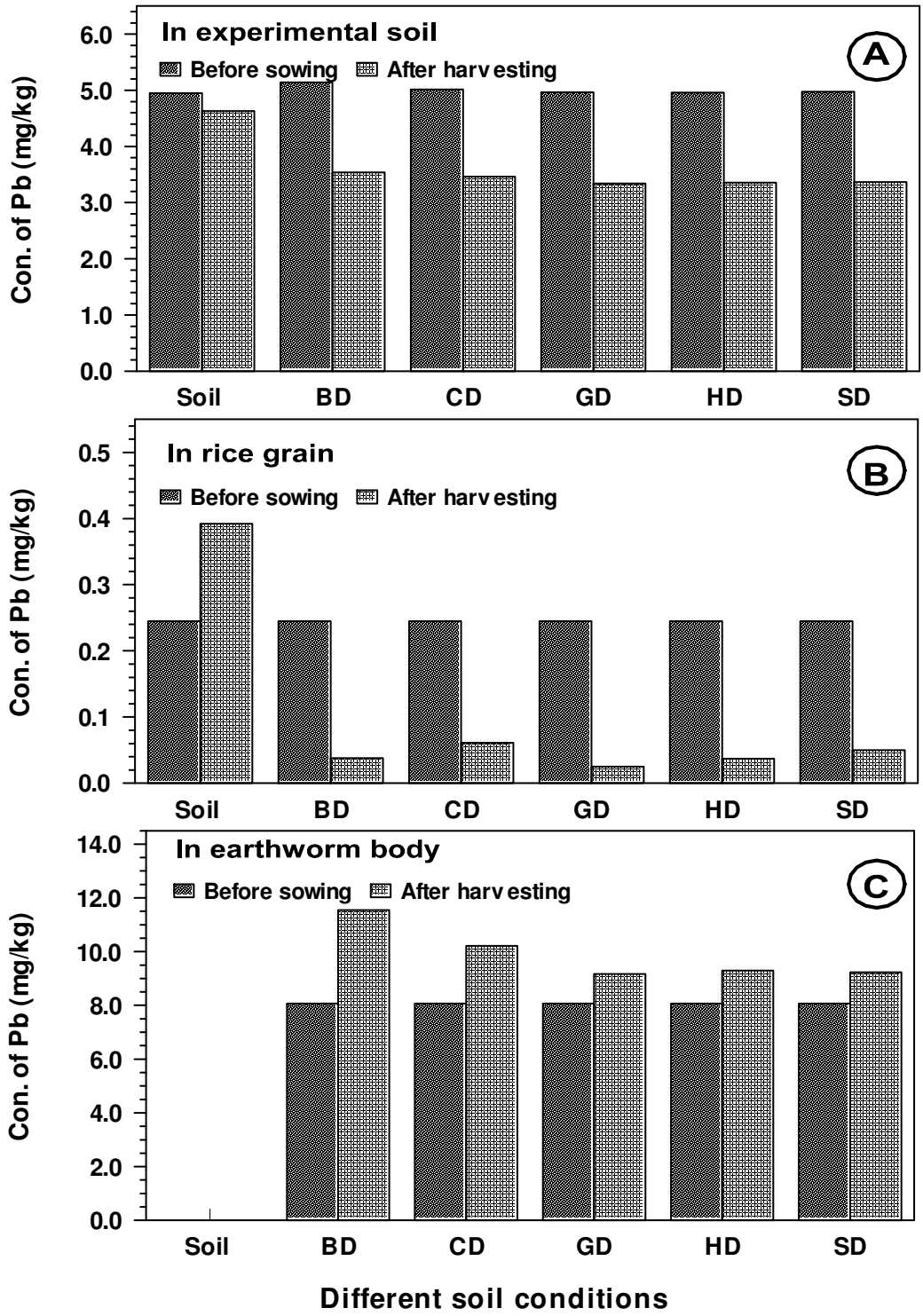



Figure 45. Concentration of lead (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

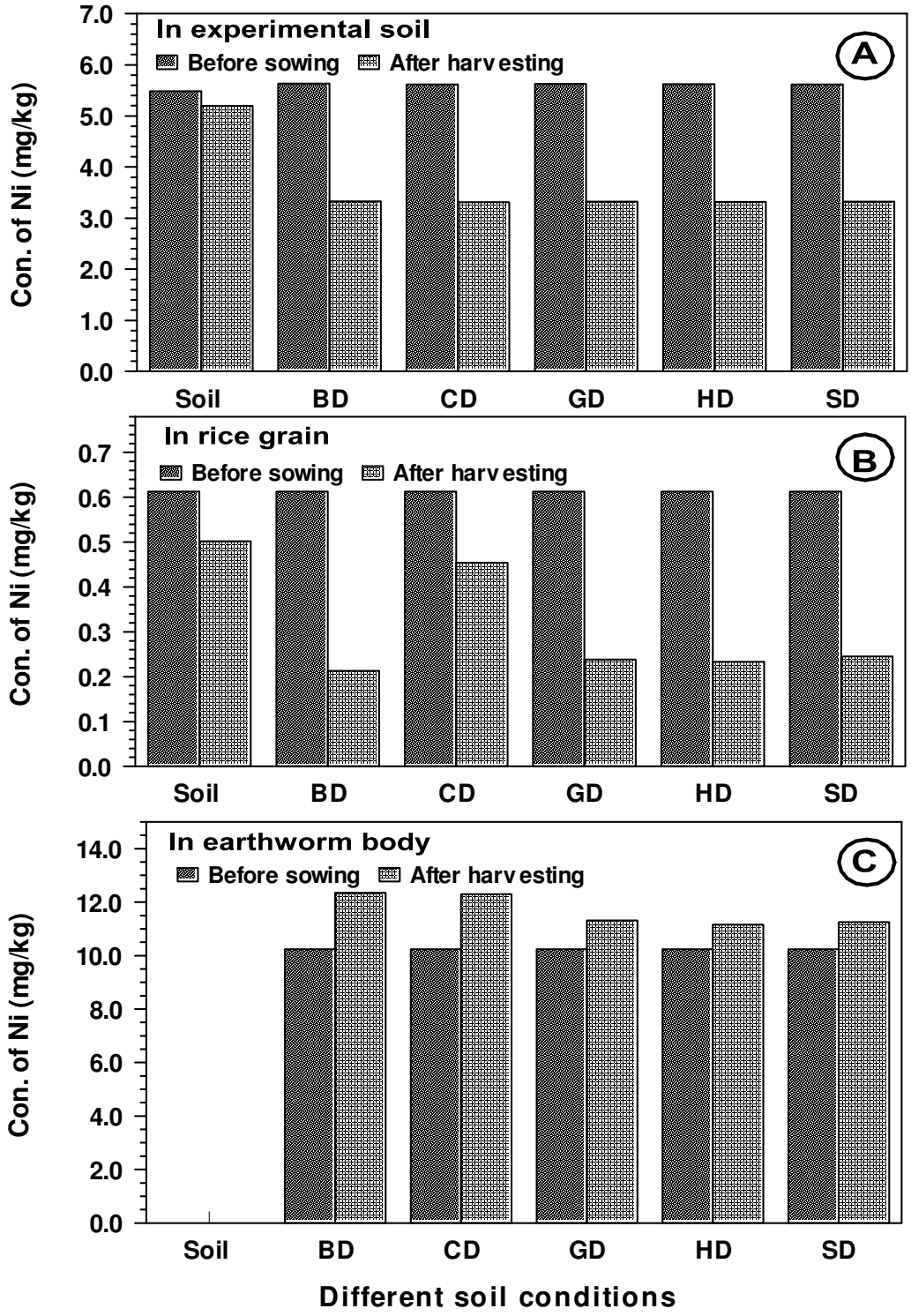



Figure 46. Concentration of nickel (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

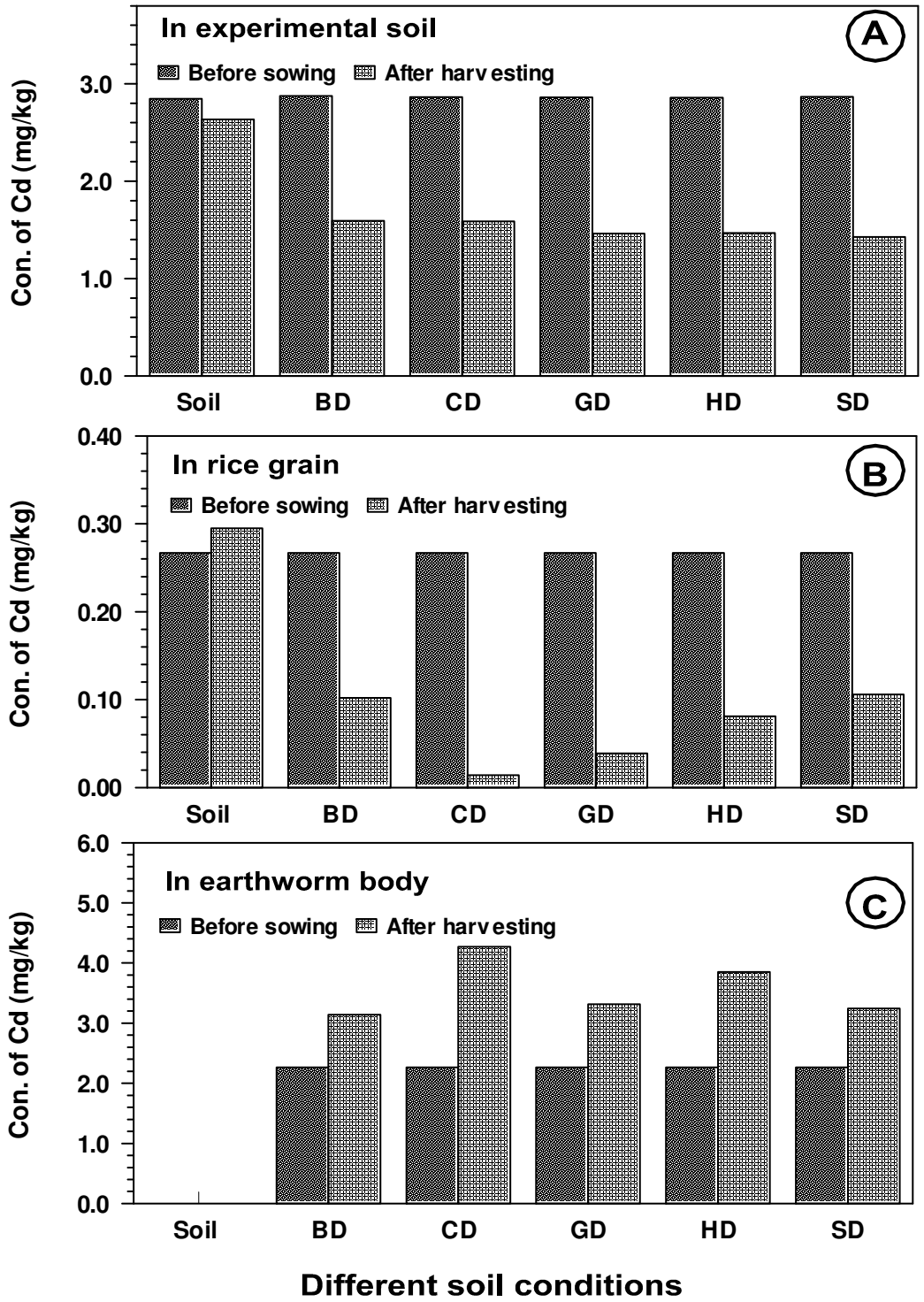



Figure 47. Concentration of cadmium (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.

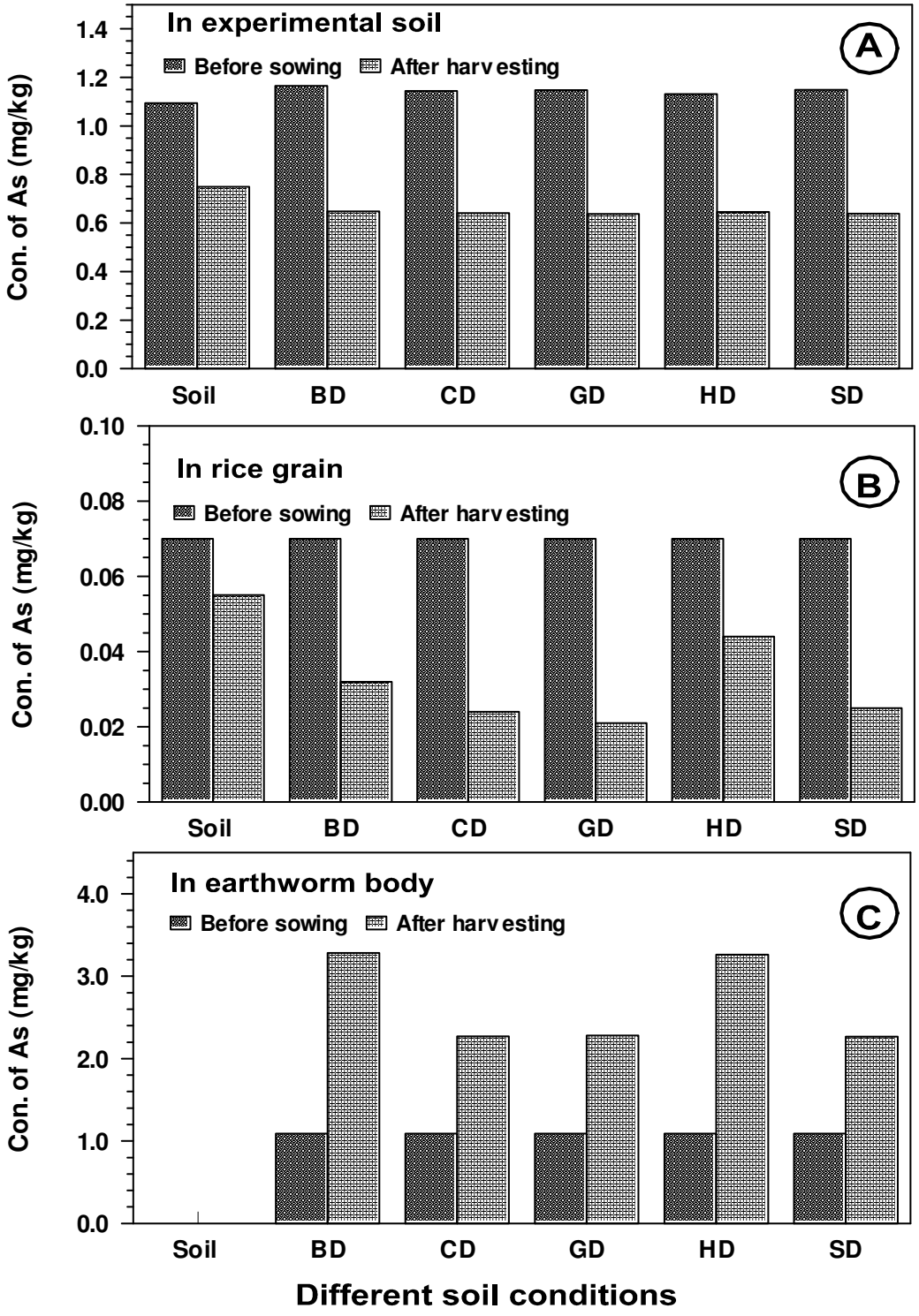



Figure 48. Concentration of arsenic (mg/kg) in experimental soil (A), rice grain (B) and earthworm body (C) before sowing and after harvesting the crop (pea) when the soil was mixed with vermicompost of different animal dungs (BD=buffalo dung, CD=cow dung, GD=goat dung, HD=horse dung, SD=sheep dung) and inoculated with earthworm *Eisenia foetida*.