***Supplementary Material***

Map

Description automatically generated with medium confidence

**Supplementary Figure S1**. Map showing the locations of *in situ* soil warming experiments that measured microbial necromass via amino sugar analysis (n = 12). Map symbols indicate the biome were soil warming experiments were conducted. Biomes included alpine and semi-arid grasslands, temperate forest, permafrost peatlands, and cropland. This map was generated using ArcMap software version 10.8.1.

***Chart, histogram

Description automatically generated***

Supplementary Figure S2. Funnel plots showing distribution of effect size estimates across total amino sugars (A), muramic acid (B), glucosamine (C), and galactosamine (D). The shape of these funnel plots indicates the absence of publication bias. Egger’s regression test for funnel plot asymmetry indicated no publication bias (p-value > 0.05).

Diagram, schematic

Description automatically generated

Supplementary Figure S3. Boxplots showing (A) total amino sugars (mg/g), (B) muramic acid, (C) glucosamine, and (D) galactosamine between treatment groups (control and warm). Necromass did not significantly differ between treatment groups, as determined by the Kruskal Wallis test (alpha level 0.05).

Diagram, schematic

Description automatically generated

Supplementary Figure S4. Boxplots showing (A) total amino sugars (mg/g), (B) muramic acid, (C) glucosamine, and (D) galactosamine between treatment groups (control and warm) across reference soil groups. Necromass did not significantly differ between treatment groups, as determined by the Kruskal Wallis test (alpha level 0.05).

Supplementary Table S1. Pairwise comparisons of total amino sugar (mg/g) estimated marginal means (EMM) across reference soil groups. EMM were extracted from the GLM that predicts total amino sugars (mg/g) with reference soil group. This table shows the contrast between soil groups, standard error (SE), and p-values. Bold p-values indicate that the EMM of total amino sugars (mg/g) significantly differ between reference soil groups at alpha level 0.05.

|  |  |  |  |
| --- | --- | --- | --- |
| **Contrast** | **EMM** | **SE** | **P-value** |
| anthrosol - arenosol | 1.0774 | 0.4118 | 0.2097 |
| anthrosol - calcisol | 0.7922 | 0.4461 | 0.7507 |
| anthrosol - cambisol\_a | 1.1320 | 0.4114 | 0.1535 |
| anthrosol - cambisol\_b | -9.3137 | 1.5728 | **0.0000** |
| anthrosol - gelisol | 1.1252 | 0.4114 | 0.1597 |
| anthrosol - histosol | -5.9175 | 0.7718 | **0.0000** |
| anthrosol - kastanozem | -21.6824 | 2.7556 | **0.0000** |
| anthrosol - luvisol | 1.0580 | 0.4163 | 0.2463 |
| anthrosol - mollisol | -3.3831 | 0.9094 | **0.0076** |
| arenosol - calcisol | -0.2852 | 0.1741 | 0.8293 |
| arenosol - cambisol\_a | 0.0546 | 0.0240 | 0.4061 |
| arenosol - cambisol\_b | -10.3911 | 1.5182 | **0.0000** |
| arenosol - gelisol | 0.0478 | 0.0240 | 0.6087 |
| arenosol - histosol | -6.9949 | 0.6535 | **0.0000** |
| arenosol - kastanozem | -22.7598 | 2.7248 | **0.0000** |
| arenosol - luvisol | -0.0194 | 0.0679 | 1.0000 |
| arenosol - mollisol | -4.4606 | 0.8114 | **0.0000** |
| calcisol - cambisol\_a | 0.3398 | 0.1733 | 0.6266 |
| calcisol - cambisol\_b | -10.1059 | 1.5279 | **0.0000** |
| calcisol - gelisol | 0.3330 | 0.1733 | 0.6542 |
| calcisol - histosol | -6.7097 | 0.6756 | **0.0000** |
| calcisol - kastanozem | -22.4746 | 2.7302 | **0.0000** |
| calcisol - luvisol | 0.2658 | 0.1846 | 0.9146 |
| calcisol - mollisol | -4.1753 | 0.8293 | **0.0000** |
| cambisol\_a - cambisol\_b | -10.4457 | 1.5181 | **0.0000** |
| cambisol\_a - gelisol | -0.0068 | 0.0172 | 1.0000 |
| cambisol\_a - histosol | -7.0495 | 0.6532 | **0.0000** |
| cambisol\_a - kastanozem | -22.8144 | 2.7248 | **0.0000** |
| cambisol\_a - luvisol | -0.0740 | 0.0658 | 0.9824 |
| cambisol\_a - mollisol | -4.5151 | 0.8112 | **0.0000** |
| cambisol\_b - gelisol | 10.4389 | 1.5181 | **0.0000** |
| cambisol\_b - histosol | 3.3962 | 1.6526 | 0.5596 |
| cambisol\_b - kastanozem | -12.3687 | 3.1191 | **0.0029** |
| cambisol\_b - luvisol | 10.3717 | 1.5194 | **0.0000** |
| cambisol\_b - mollisol | 5.9306 | 1.7211 | **0.0203** |
| gelisol - histosol | -7.0427 | 0.6532 | **0.0000** |
| gelisol - kastanozem | -22.8076 | 2.7248 | **0.0000** |
| gelisol - luvisol | -0.0672 | 0.0658 | 0.9911 |
| gelisol - mollisol | -4.5083 | 0.8112 | **0.0000** |
| histosol - kastanozem | -15.7649 | 2.8019 | **0.0000** |
| histosol - luvisol | 6.9755 | 0.6563 | **0.0000** |
| histosol - mollisol | 2.5343 | 1.0414 | 0.3056 |
| kastanozem - luvisol | 22.7404 | 2.7255 | **0.0000** |
| kastanozem - mollisol | 18.2992 | 2.8429 | **0.0000** |
| luvisol - mollisol | -4.4412 | 0.8137 | **0.0000** |

Supplementary Table S2. Pairwise comparisons of muramic acid (mg/g) estimated marginal means (EMM) across reference soil groups. EMM were extracted from the GLM that predicts muramic acid (mg/g) with reference soil group. This table shows the contrast between soil groups, standard error (SE), and p-values. Bold p-values indicate that the EMM of muramic acid (mg/g) significantly differ between reference soil groups at alpha level 0.05

|  |  |  |  |
| --- | --- | --- | --- |
| **Contrast** | **EMM** | **SE** | **P-value** |
| anthrosol - arenosol | 31.4636 | 5.1419 | **0.0000** |
| anthrosol - calcisol | 32.6832 | 5.2188 | **0.0000** |
| anthrosol - cambisol\_a | 27.0259 | 5.2924 | **0.0000** |
| anthrosol - cambisol\_b | -38.9336 | 8.2913 | **0.0001** |
| anthrosol - histosol | 33.5335 | 5.0529 | **0.0000** |
| anthrosol - kastanozem | 1.6909 | 6.0781 | 1.0000 |
| anthrosol - luvisol | 42.0097 | 5.0386 | **0.0000** |
| anthrosol - mollisol | -1.3072 | 7.2082 | 1.0000 |
| arenosol - calcisol | 1.2195 | 1.7857 | 0.9990 |
| arenosol - cambisol\_a | -4.4377 | 1.9905 | 0.3863 |
| arenosol - cambisol\_b | -70.3973 | 6.6857 | **0.0000** |
| arenosol - histosol | 2.0698 | 1.2187 | 0.7478 |
| arenosol - kastanozem | -29.7728 | 3.5910 | **0.0000** |
| arenosol - luvisol | 10.5460 | 1.1579 | **0.0000** |
| arenosol - mollisol | -32.7708 | 5.2831 | **0.0000** |
| calcisol - cambisol\_a | -5.6573 | 2.1815 | 0.1892 |
| calcisol - cambisol\_b | -71.6168 | 6.7450 | **0.0000** |
| calcisol - histosol | 0.8503 | 1.5107 | 0.9998 |
| calcisol - kastanozem | -30.9923 | 3.7004 | **0.0000** |
| calcisol - luvisol | 9.3265 | 1.4621 | **0.0000** |
| calcisol - mollisol | -33.9904 | 5.3580 | **0.0000** |
| cambisol\_a - cambisol\_b | -65.9595 | 6.8021 | **0.0000** |
| cambisol\_a - histosol | 6.5076 | 1.7480 | **0.0061** |
| cambisol\_a - kastanozem | -25.3350 | 3.8034 | **0.0000** |
| cambisol\_a - luvisol | 14.9838 | 1.7062 | **0.0000** |
| cambisol\_a - mollisol | -28.3331 | 5.4297 | **0.0000** |
| cambisol\_b - histosol | 72.4671 | 6.6175 | **0.0000** |
| cambisol\_b - kastanozem | 40.6245 | 7.4298 | **0.0000** |
| cambisol\_b - luvisol | 80.9433 | 6.6066 | **0.0000** |
| cambisol\_b - mollisol | 37.6264 | 8.3796 | **0.0002** |
| histosol - kastanozem | -31.8426 | 3.4625 | **0.0000** |
| histosol - luvisol | 8.4762 | 0.6591 | **0.0000** |
| histosol - mollisol | -34.8407 | 5.1966 | **0.0000** |
| kastanozem - luvisol | 40.3188 | 3.4416 | **0.0000** |
| kastanozem - mollisol | -2.9981 | 6.1980 | 0.9999 |
| luvisol - mollisol | -43.3169 | 5.1827 | **0.0000** |