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## Supplementary Material

# Sugar Press Mud as a Proposed Futuristic Aqua-fertilizer – Multi-Elemental Quantitative Characterization by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)

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**Supplementary Table I.- ICP-OES instrumental operating conditions.**

| Parameters | Settings |
|---|---|
| Auxiliary gas flow (Air) rate | 0.20 L/min |
| Nebulizer gas flow (Argon) rate | 0.80 L/min |
| Plasma gas flow rate | 15.0 L/min |
| Sample uptake flow rate | 1.50 mL/min |
| Nebulizer start up | Instant |
| Plasma view | Axial |
| View distance | 15.0 |
| Plasma condition | Same for all elements |
| Plasma aerosol type | Wet |
| Measurement processing mode | Peak area |
| Background correction | 1 or 2 points, selected manually |
| Warm up time | 45 min |
| First rinse time | 15 min |
| Rinse time between samples | 35 sec |
| Read delay time | 60 sec |
| Number of sample replicates | 3 |
| Number of element replicates | 3 |

**Supplementary Table II.- Limits of detection for all elements.**

| Metals | Concentration / detection range ($\mu gL^{-1}$)* | L.D.L. of instrument ($\mu gL^{-1}$)** | Minimum detection range ($\mu gL^{-1}$)*** |
|---|---|---|---|
| **Essential macro-mineral elements** | | | |
| Ca | 17-47 170 | 0.50 | 0.30 |
| K | 347-14 151 | NA | 20.00 |
| Mg | 34-13 868 | NA | 0.10 |
| Na | 35-47 170 | NA | 3.50 |
| **Essential mineral trace elements** | | | |
| Co | 17-2340 | 0.25 | 1.50 |
| Cr | 13-1406 | 0.25 | 0.50 |
| Cu | 8-1887 | 0.90 | 0.45 |
| Fe | 13-9359 | 0.20 | 1.00 |
| Mn | 4-1887 | 0.03 | 0.10 |
| Ni | 17-47 170 | 0.40 | 0.75 |
| Zn | 7-7076 | 0.20 | 0.80 |
| **Toxic trace elements** | | | |
| Al | 69-4792 | 0.90 | 2.50 |
| Ba | 9-377 | NA | 0.10 |
| Cd | 9-1943 | 0.07 | 1.00 |
| La | NA | NA | 0.80 |
| Li | NA | NA | 0.30 |
| Pb | 42-4717 | 1.40 | 3.00 |
| Sr | NA | NA | 0.05 |

*, established by AOAC; **, established by Perkin Elmer; ***, established by this research; NA, not available.

**Supplementary Table III.- Multi-elements parameters.**

| Standard Stock Solutions | Elements | Wavelength (nm) | Stock standards strengths ($mgL^{-1}$) | Working standards for calibration ($mgL^{-1}$) | | | | | Correction coefficient of calibration | QCS (% recovery) |
|---|---|---|---|---|---|---|---|---|---|---|
| Standard Combined Solution-I | Al | 396.153 | 200 | 25 | 50 | 75 | 100 | 150 | 0.999923 | 99.1 |
| | Na | 589.592 | 200 | 25 | 50 | 75 | 100 | 150 | 0.998409 | 97.8 |
| | K | 766.490 | 400 | 50 | 100 | 150 | 200 | 300 | 0.999615 | 101.5 |
| | Ca | 317.933 | 1000 | 75 | 250 | 375 | 500 | 750 | 0.999348 | 100.1 |
| | Cr | 267.716 | 20 | 0.05 | 0.1 | 0.15 | 0.2 | 0.25 | 0.999823 | 99.9 |
| | Ni | 231.604 | 20 | 0.05 | 0.1 | 0.15 | 0.2 | 0.25 | 0.999273 | 99.7 |
| Standard Combined Solution-II | Ba | 233.527 | 100 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 0.997602 | 91.4 |
| | Fe | 238.204 | 10,000 | 100 | 200 | 300 | 400 | 500 | 0.995743 | 103.1 |
| Standard Combined Solution-III | Co | 238.892 | 100 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 0.996764 | 104.6 |
| | Cu | 213.597 | 100 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 0.998023 | 97.6 |
| Standard Combined Solution-IV | Mn | 257.610 | 10 | 2 | 4 | 6 | 8 | 10 | 0.999849 | 99.1 |
| | Sr | 407.771 | 10 | 2 | 4 | 6 | 8 | 10 | 0.999278 | 104.7 |
| | Zn | 206.200 | 10 | 2 | 4 | 6 | 8 | 10 | 0.999140 | 101.0 |
| Standard Solution-V | Mg | 285.213 | 1000 | 25 | 50 | 75 | 100 | 150 | 0.995198 | 98.4 |
| Standard Solution-VI | Pb | 217.000 | 50 | 0.05 | 0.1 | 0.15 | 0.2 | 0.25 | 0.999801 | 100.9 |
| | Cd | 214.440 | 50 | 0.05 | 0.1 | 0.15 | 0.2 | 0.25 | 0.999863 | 97.5 |
| Standard Solution-VII | La | 398.852 | 10 | 0.1 | 0.25 | 0.5 | 0.75 | 1.0 | 0.999897 | 98.2 |
| | Li | 670.784 | 10 | 0.1 | 0.25 | 0.5 | 0.75 | 1.0 | 0.996356 | 96.9 |

**Supplementary Table VI.- The overall descriptive statistics of elemental concentration ($\mu gg^{-1}$ dry weight) in press mud from various Sugar Mills of South Punjab.**

| Elements | n | Range | | Mean | Median | Std. Error | Std. Dev. | Variance | 95% confidence interval | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | | | | | | Lower bound | Upper bound |
| **Essential macro-mineral elements** | | | | | | | | | | |
| Ca | 15 | 7761.50 | 18470.00 | 10967.5120 | 9364.00 | 965.74965 | 3740.33232 | 13990085.837 | 8896.1850 | 13038.8390 |
| K | 15 | 4250.50 | 6894.50 | 5627.0853 | 5799.00 | 236.14350 | 914.57985 | 836456.295 | 5120.6079 | 6133.5628 |
| Na | 15 | 5826.00 | 8576.50 | 7023.7100 | 6735.50 | 228.97804 | 886.82815 | 786464.174 | 6532.6009 | 7514.8191 |
| Mg | 15 | 4015.25 | 5265.00 | 4670.9400 | 4860.50 | 114.90827 | 445.03782 | 198058.659 | 4424.4863 | 4917.3937 |
| **Essential mineral trace elements** | | | | | | | | | | |
| Co | 15 | 18.99 | 35.60 | 24.3900 | 22.75 | 1.42655 | 5.52502 | 30.526 | 21.3303 | 27.4497 |
| Cr | 15 | 0.01 | 9.15 | 4.4960 | 5.90 | 0.99844 | 3.86693 | 14.953 | 2.3546 | 6.6374 |
| Cu | 15 | 12.25 | 50.33 | 28.0093 | 26.85 | 3.24709 | 12.57592 | 158.154 | 21.0450 | 34.9736 |
| Fe | 15 | 2475.30 | 6725.00 | 4402.3200 | 3567.50 | 438.68621 | 1699.02438 | 2886683.829 | 3461.4317 | 5343.2083 |
| Mn | 15 | 108.65 | 283.50 | 200.8667 | 196.50 | 15.21585 | 58.93072 | 3472.830 | 168.2319 | 233.5014 |
| Ni | 15 | 7.70 | 35.35 | 22.8933 | 26.15 | 2.83459 | 10.97830 | 120.523 | 16.8138 | 28.9729 |
| Zn | 15 | 82.50 | 128.00 | 109.9147 | 115.50 | 4.13941 | 16.03185 | 257.020 | 101.0365 | 118.7928 |
| **Toxic trace elements** | | | | | | | | | | |
| Al | 15 | 182.10 | 436.10 | 283.2733 | 265.15 | 20.60344 | 79.79680 | 6367.529 | 239.0833 | 327.4633 |
| Ba | 15 | 27.85 | 55.55 | 37.8400 | 36.15 | 2.30798 | 8.93876 | 79.901 | 32.8899 | 42.7901 |
| Cd | 15 | 0.00 | 1.85 | 0.6612 | 0.582 | 0.17893 | 0.69300 | 0.480 | 0.2774 | 1.0450 |
| La | 15 | 0.00 | 5.20 | 3.2233 | 3.70 | 0.45901 | 1.77773 | 3.160 | 2.2389 | 4.2078 |
| Li | 15 | 12.85 | 28.60 | 21.2907 | 23.50 | 1.44001 | 5.57715 | 31.105 | 18.2021 | 24.3792 |
| Pb | 15 | 8.80 | 74.90 | 31.5660 | 27.00 | 6.17300 | 23.90793 | 571.589 | 18.3262 | 44.8058 |
| Sr | 15 | 34.25 | 69.35 | 45.8393 | 40.25 | 3.08945 | 11.96540 | 143.171 | 39.2131 | 52.4655 |

**Supplementary Table V.- ANOVA results of multi-elements**

| Elements | df | F | Sig. | Elements | df | F | Sig. |
|---|---|---|---|---|---|---|---|
| Ca | 1,14 | 308.430 | 0.000 | Ni | 1,14 | 785.969 | 0.000 |
| K | 1,14 | 356.899 | 0.000 | Zn | 1,14 | 39.427 | 0.000 |
| Na | 1,14 | 213.404 | 0.000 | Al | 1,14 | 188.395 | 0.000 |
| Mg | 1,14 | 40.248 | 0.000 | Ba | 1,14 | 181.665 | 0.000 |
| Co | 1,14 | 100.088 | 0.000 | Cd | 1,14 | 1799.955 | 0.000 |
| Cr | 1,14 | 715.940 | 0.000 | La | 1,14 | 703.527 | 0.000 |
| Cu | 1,14 | 793.256 | 0.000 | Li | 1,14 | 145.696 | 0.000 |
| Fe | 1,14 | 1558.526 | 0.000 | Pb | 1,14 | 1911.278 | 0.000 |
| Mn | 1,14 | 255.127 | 0.000 | Sr | 1,14 | 190.524 | 0.000 |

P value is significant at the 0.0001 level.

**Supplementary Table VI.- Correlation results of multi- elements.**

| | Ca | K | Na | Mg | Co | Cr | Cu | Fe | Mn | Ni | Zn | Al | Ba | Cd | La | Li | Pb | Sr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ca** | 1 | | | | | | | | | | | | | | | | | |
| **K** | .632 | 1 | | | | | | | | | | | | | | | | |
| **Na** | -.006** | -.001** | 1 | | | | | | | | | | | | | | | |
| **Mg** | .069 | -.777 | -.762 | 1 | | | | | | | | | | | | | | |
| **Co** | .000** | .865 | -.016* | .200 | 1 | | | | | | | | | | | | | |
| **Cr** | .023* | .000** | -.000** | .236 | .037* | 1 | | | | | | | | | | | | |
| **Cu** | -.089 | .179 | .521 | -.978 | -.000** | -.913 | 1 | | | | | | | | | | | |
| **Fe** | .001** | .049* | -.003** | .005** | .046* | .000** | .838 | 1 | | | | | | | | | | |
| **Mn** | -.650 | -.974 | .374 | .002** | -.713 | .636 | .270 | .259 | 1 | | | | | | | | | |
| **Ni** | -.001** | -.007** | .000** | -.039* | -.027* | -.000** | -.979 | -.000** | -.525 | 1 | | | | | | | | |
| **Zn** | .186 | .001** | -.003** | .156 | .103 | .000** | .991 | .003** | .113 | -.001** | 1 | | | | | | | |
| **Al** | .672 | -.278 | .626 | -.131 | -.421 | -.103 | .747 | -.422 | .003** | .370 | -.003** | 1 | | | | | | |
| **Ba** | .000** | .642 | -.014* | .005** | .000** | .009** | -.083 | .000** | .560 | -.000** | .044* | -.489 | 1 | | | | | |
| **Cd** | -.625 | .000** | -.036* | -.554 | .531 | .009** | -.925 | .603 | .715 | -.228 | .002** | -.004** | .988 | 1 | | | | |
| **La** | .028* | .002** | -.000** | -.459 | .091 | .002** | -.655 | .051 | -.034* | -.005** | .089 | .528 | .135 | .115 | 1 | | | |
| **Li** | .081 | .000** | -.000** | .697 | .220 | .000** | .575 | .002** | -.845 | -.000** | .001** | -.410 | .097 | .012* | .000** | 1 | | |
| **Pb** | -.009** | -.836 | .333 | -.084 | -.681 | -.430 | -.341 | -.007** | .942 | .036* | .949 | -.056 | -.054 | .029* | -.303 | -.343 | 1 | |
| **Sr** | -.154 | .035* | -.332 | -.342 | .942 | .148 | -.918 | -.667 | .552 | -.878 | .026* | -.002** | -.464 | .000** | .585 | .178 | .001** | 1 |

*, Correlation is significant at the 0.05 level (2-tailed); **, Correlation is significant at the 0.01 level (2-tailed).