

A Review of Enhancement of Biohydrogen Productions by Chemical Addition Using a Supervised Machine Learning Method

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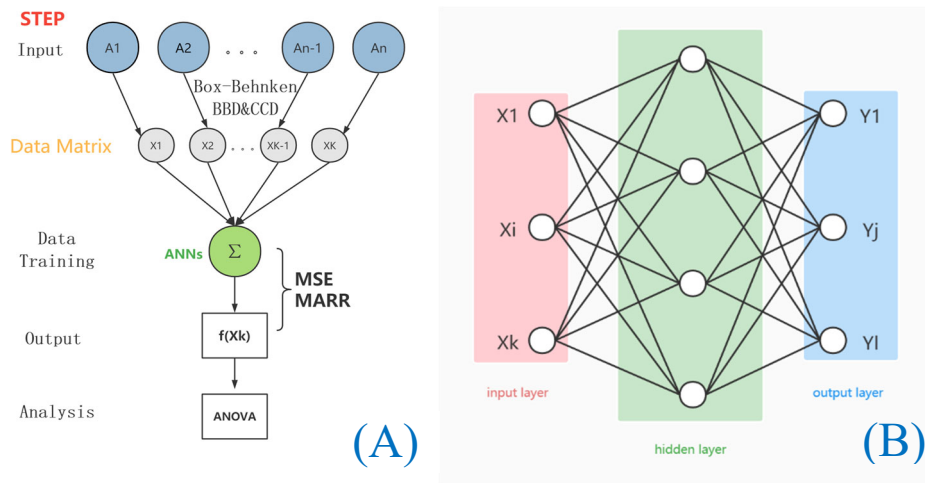


Figure S1. Schematic diagram of methodology: (A) The procedures flowchart, (B) ANNs construction: feed forward three layers networks.

Table S1. Ions comparisons upon BioH₂ generation, - refers to all data missing as, for convenience of calculation, the missing value was replaced by the averaged value during artificial neuron network learning process.

| Mg ²⁺ /mmol/L | Cu ²⁺ /mmol/L | Na ⁺ /mmol/L | NH ₄ ⁺ /mmol/L | K ⁺ /mmol/L | HY/mmol/g | HER/mmol/L.h ⁻¹ | Reference |
|--------------------------|--------------------------|-------------------------|--------------------------------------|------------------------|-----------|----------------------------|-----------|
| 1.05 | 0.002 | 10.21 | 17.57 | 1.38 | 2.9 | 5.4 | [45] |
| 0.99 | - | 47 | - | 1.1 | 3 | 13.07 | [46] |
| 1.23 | - | - | 9.09 | - | 20 | 0.4 | [47] |
| 67.9 | - | 49.9 | 420.8 | 122.5 | 13.3 | 2 | [48] |
| 5.2 | - | 32.5 | - | 25.1 | 0.9 | 2.4 | [49] |
| 1.754 | - | 9.58 | 1.77 | 2.29 | 15.9 | 10.1 | [50] |
| 0.35 | - | 0.939 | 0.39 | 0.46 | 12.9 | 5.69 | [51] |
| 1.05 | 0.002 | 10.21 | 17.57 | 1.38 | 5 | 13.07 | [46] |
| 1.23 | - | 26.37 | 9.17 | - | 24.2 | 0.8 | [47] |
| 1.02 | - | 14.6 | 3.17 | - | 1.92 | 2.5 | [52] |
| 0.62 | - | 37.27 | - | - | 16.75 | 102.5 | [25] |
| 2.15 | - | - | 2 | - | 7.85 | 62.4 | [24] |
| 0.4 | - | 12.7 | 2.5 | 0.7 | 1.9 | 49.4 | [53] |
| 0.11 | 0.06 | 0.1 | 6.6 | 0.4 | 8.4 | 0.6 | [42] |
| 3.596 | - | 26.37 | 45.05 | - | 3.875 | 1.92 | [54] |
| 3.596 | - | - | 45.05 | - | 9.2 | 3.1 | [54] |
| 1.04 | - | 14.6 | 3.17 | - | 1.92 | 2.5 | [52] |
| 3.596 | - | 26.37 | 10 | 2 | 10.1 | 0.23 | [55] |
| 2.25 | - | 100.02 | 49.94 | 49.97 | 11.66 | 3.2 | [30] |
| 0.348 | 0.097 | 5.23 | 3.74 | 0.735 | 1.58 | 0.066 | [56] |
| 0.035 | - | 0.01 | 42.2 | 0.38 | 6.7 | 0.23 | [57] |
| 0.985 | - | 75.47 | 9.49 | 2.87 | 10.4 | 6 | [58] |
| 1.5 | 0.01 | - | 9.7 | 3 | 14.1 | 11.5 | [59] |
| 1.02 | 0.003 | 43 | - | 1.5 | 2.4 | 10.3 | [46] |
| 0.2 | 0.02 | 3.9 | 7.8 | 0.8 | 1.11 | 1.5 | [20] |
| 1.1 | 0.06 | 42.7 | 9.7 | 36.1 | 9.5 | 30 | [27] |
| 1.04 | - | - | 10 | 2 | 11.7 | 0.28 | [55] |
| 1.4 | 0.05 | - | 9.9 | 3.2 | 12.7 | 10.4 | [59] |
| 0.99 | - | 47 | - | 1.1 | 10.8 | 1.3 | [60] |
| 0.99 | - | 47 | - | 1.1 | 2.7 | 11.5 | [46] |
| 0.11 | 0.07 | 0.09 | 521 | 9.2 | 1.21 | 0.22 | [27] |
| 0.11 | 0.06 | 0.1 | 6.6 | 0.4 | 7.25 | 0.5 | [42] |
| 14.8 | - | - | 10.4 | - | 15.7 | 44.9 | [25] |

Table S2. ANOVA analysis for the effect of ions concentration upon HY, where r^2 0.94, Adjust r^2 0.93, Predicted r^2 0.93, adequate precision (AP) 15.

| Source | Sum of squares | DF | Mean square | F-value | <i>p</i> -value |
|--------------------|----------------|----|-------------|---------|-----------------|
| Model | 2309.24 | 20 | 115.46 | 1.32 | 0.2554 |
| A-Mg ²⁺ | 19.50 | 1 | 19.50 | 0.2223 | 0.6414 |
| B-Cu ²⁺ | 31.18 | 1 | 31.18 | 0.3553 | 0.5565 |
| C-Na ⁺ | 51.66 | 1 | 51.66 | 0.5887 | 0.4501 |
| D-NH ⁴⁺ | 32.96 | 1 | 32.96 | 0.3756 | 0.5455 |
| E-K ⁺ | 33.49 | 1 | 33.49 | 0.3816 | 0.5423 |
| AB | 178.00 | 1 | 178.00 | 2.03 | 0.1667 |
| AC | 0.0263 | 1 | 0.0263 | 0.0003 | 0.9863 |
| AD | 456.62 | 1 | 456.62 | 5.20 | 0.0313 |
| AE | 2.38 | 1 | 2.38 | 0.0271 | 0.8706 |
| BC | 48.12 | 1 | 48.12 | 0.5483 | 0.4659 |
| BD | 69.86 | 1 | 69.86 | 0.7960 | 0.3808 |
| BE | 144.30 | 1 | 144.30 | 1.64 | 0.2115 |
| CD | 2.01 | 1 | 2.01 | 0.0229 | 0.8810 |
| CE | 1.52 | 1 | 1.52 | 0.0173 | 0.8963 |
| DE | 54.59 | 1 | 54.59 | 0.6221 | 0.4377 |
| A ² | 484.11 | 1 | 484.11 | 5.52 | 0.0270 |
| B ² | 244.16 | 1 | 244.16 | 2.78 | 0.1078 |
| C ² | 565.76 | 1 | 565.76 | 6.45 | 0.0177 |
| D ² | 681.36 | 1 | 681.36 | 7.76 | 0.0100 |
| E ² | 375.15 | 1 | 375.15 | 4.28 | 0.0492 |
| Residue | 2193.86 | 25 | 87.75 | | |
| Lack of fit | 2193.86 | 20 | 109.69 | | |
| Pure Error | 0.0000 | 5 | 0.0000 | | |
| Cor total | 4503.10 | 45 | | | |