1. ***Instrumental analysis in incubation experiments***

# A Bruker Vertex 70 spectrometer (Bruker Optics Inc., Billerica, MA) fitted with a Pike Gladi ATR accessory (Pike Technologies, Madison, WI) was used to acquire the Attenuated total reflection Fourier-transform infrared (ATR-FTIR) spectra in the supernatant and pellet samples. Filtered supernatant solutions (0.22 μm) and pellet suspensions were dropped added-cast (5 µl) onto the internal reflection element (IRE) of the ATR-FTIR and dried under N2 flow before the spectra collection. All spectra were collected the wavelength from 4500 to 150 cm−1, and the spectra were representative of the average of 100 scans with 2 cm−1 spectral resolution. After collection, the spectra underwent atmospheric compensation, smoothed using nine-point Savitzky-Golay and the effect of instrumental drift was removed by baseline correction. All subsequent spectral processing was performed with OPUS v.7.2 software (Bruker Corp., Billerica, MA).

Field emission scanning electron microscopy (FESEM) were used to determine the morphology of the precipitates (i.e., pellets). The morphology was characterized using a Carl Zeiss Supra 55 with an extra high tension of 15 kV, a work distance from 8.6 to 8.8 nm, and elemental analysis was conducted with an Oxford Aztec X-Max 150.

Quercetin-Fe(Ⅲ) coprecipitates were ultrasonically dispersed and dropped onto a grid of carbon-coated copper, air-dried and then observed by high-resolution transmission electron microscopy (HRTEM). The images were collected by HITACHI microscope (7500, Japan) at an acceleration voltage of 200 keV. Using ImageJ (<https://imagej.nih.gov/ij/download.html>), the particle-size distribution was estimated (NIH, Bethesda, MD, USA). In brief, the first step was to convert the pixel values into nanometers using scaling factor. The analysis was then done by selecting the particle analysis option on the ImageJ toolbar and converting it into binary images (J. Kumara, 2012). HRTEM and SAED observations were performed with a JEOL JEM-2100F microscope to complete data and image collection.

The X-ray photoelectron spectrometer (XPS) data of C 1*s* and Fe 2p were collected using a PHI X-ray photoelectron spectrometer (UlVAC-PHI5000 Versa Probe, Japan) with a monochromatized Al Kα X-ray source (1486.69 eV). The binding energy was corrected through the hydrocarbon C 1s spectrum at 284.6 eV (Zhu et al., 2014). The surface charge caused by the photo ejection process was balanced with a 6eV flood gun. A detector resolution corresponding to 0.125 eV per channel was used to record the spectra to optimize the signal-to-noise ratio. The XPS data analyses were performed using Avantage (ThermoFisher Scientific**,** America).

1. ***Synthesis of 2-line ferrihydrite***

Dissolved 40 g FeCl3∙6H2O in 500 ml distilled water and added 330 ml M KOH to bring the pH to 7-8. The last 20 ml should be added drop-wise with constant checking of the pH. Stir vigorously, centrifuged at 8000 rpm for 10 min, and then washed five times rapidly until free from electrolytes. Freeze dried and ground for spectral analysis.

1. ***Flavonoid inputs from pig manure as a percentage of soil mass***

The content of flavonoids that obtained from pig manure after 7 years was calculated as follows:

Flavonoids stocks (Flavonoids stock, g ha−1) = Flavonoids \* 12000 \* 7 / 1000 = 11007.36

Where *Flavonoids* are flavonoids content within the pig manure (131.04 mg kg−1), 12000 kg ha−1 is the application of pig manure every year. 7 years is timing of application of pig manure.

On the assumption that the pig manure was applied only to the surface layer and the flavonoids didn’t decompose, the flavonoids content in the surface layer was calculated as follows:

Flavonoids content (mg kg−1) = Flavonoids stock / (Bulk density × Soil depth × Area × 1000)

=11007.36 / (1.15 × 0.2 ×10000 ×1000)

=4.78

the units of *Bulk density* and *Soil depth* were t m−3 and m, respectively, the unit of *Area* was m2 and 1000 is a factor to adjust the units.

Therefore, flavonoid compounds input directly from pig manure should be less than 4.78 mg kg−1, due to the decomposition of flavonoid compounds, relatively.

1. ***The composite score model in principal component analysis and formula F calculate***

F1 = 0.32 \* x1 - 0.31 \* x2 + 0.09 \* x3 + 0.26 \* x4 + 0.31 \* x5 + 0.28 \* x6 + 0.21 \* x7 + 0.3 \* x8 + 0.32 \* x9 + 0.31 \* x10 + 0.32 \* x11 + 0.24 \* x12 + 0.26 \* x13

F2 = 0.02 \* x1 - 0.05 \* x2 + 0.64 \* x3 - 0.38 \* x4 + 0.17 \* x5 + 0.05 \* x6 + 0.49 \* x7 - 0.2 \* x8 - 0.04 \* x9 - 0.11 \* x10 + 0.08 \* x11 + 0.08 \* x12 - 0.34 \* x13

**The comprehensive scores：**

F = 72.447 \* F1 + 16.891 \* F2

NPKM: 336.36，NPKS: -13.69；NPK: -99.0974；Control: -223.63