

Cow manure digestate as an alternative sustainable cultivation medium for sulfide-oxidizing bacteria aimed at biogas desulfurization

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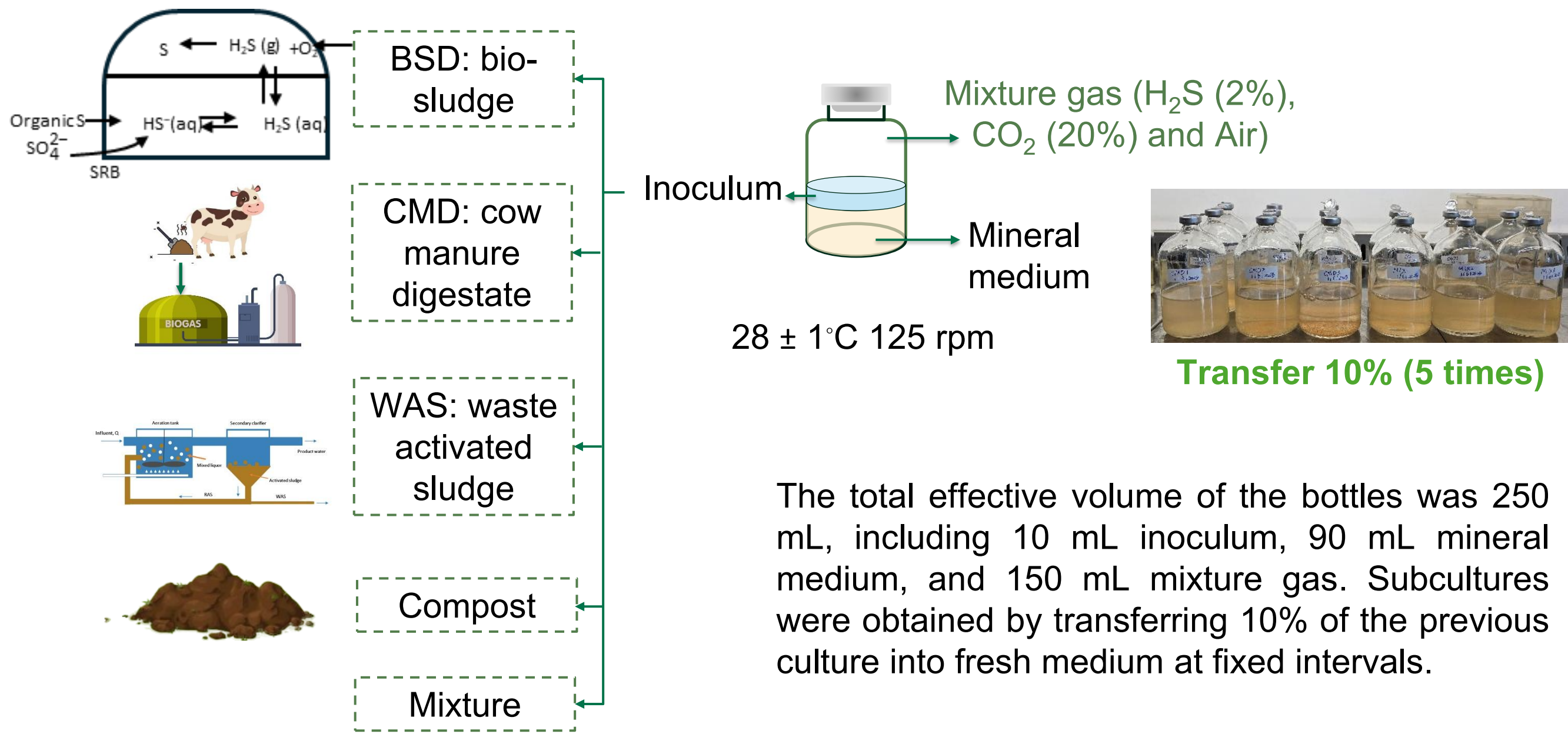
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BACKGROUND:

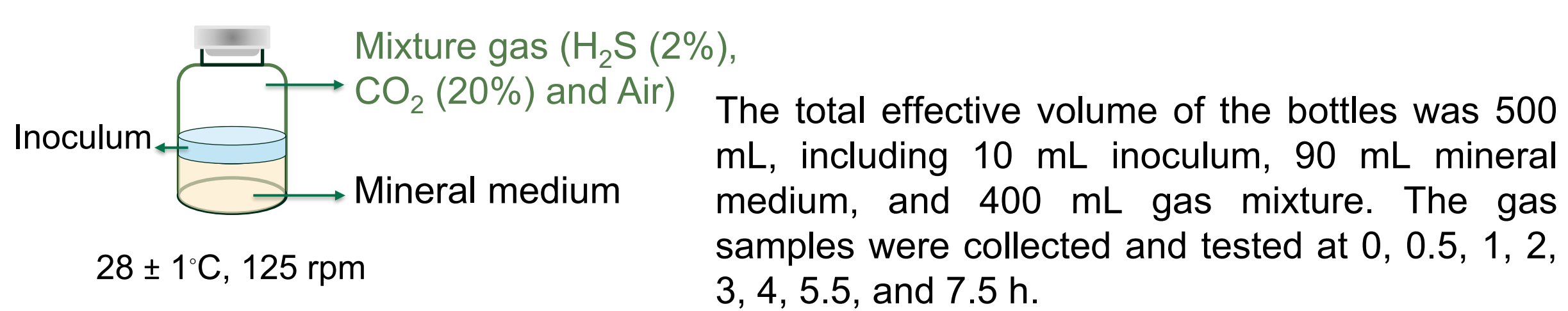
Hydrogen sulfide (H₂S) is a major contaminant in biogas that limits its utilization due to toxicity and corrosion. Biological desulfurization is an environmentally friendly and energy-efficient alternative to physicochemical removal methods. Sulfide-oxidizing bacteria (SOB) oxidize sulfide or elemental sulfur to sulfate, enabling H₂S removal. However, ex situ biological desulfurization systems often incur high operational costs due to continuous nutrient supplementation. This study evaluates cow manure digestate as a sustainable and cost-effective alternative to conventional mineral media for SOB cultivation, focusing on the effects of ammonia concentration and indigenous microbial competition.

METHODS:

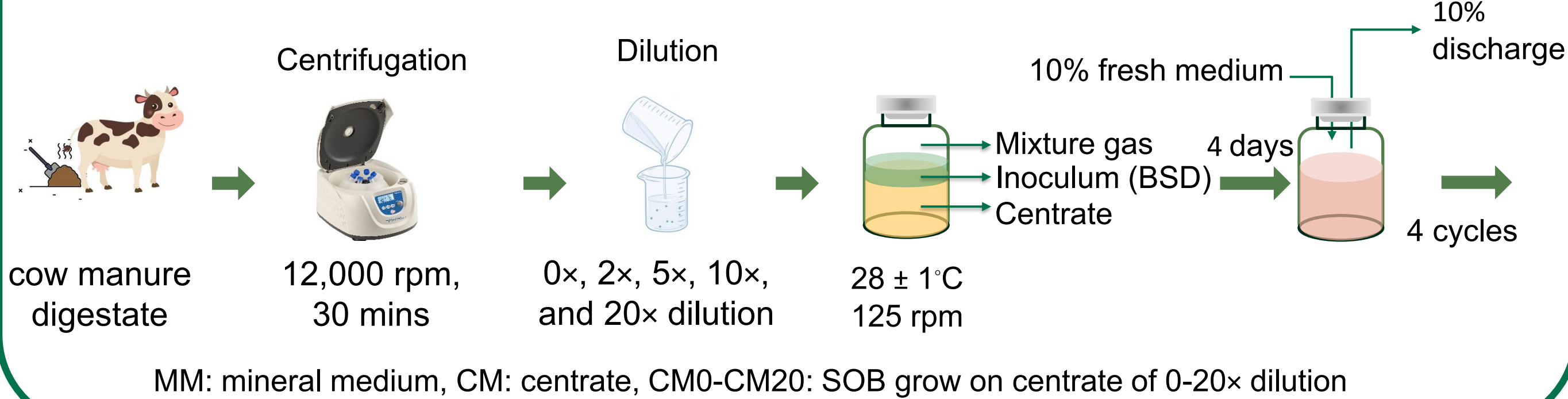
1. Enrichment SOB from different environmental samples:



2. Estimation of the specific sulfide-oxidation activity of different mixture SOB :



3. SOB cultivation on centrate as a sustainable alternative to mineral medium :



RESULTS :

2. Specific sulfide-oxidation activity of different mixture SOB

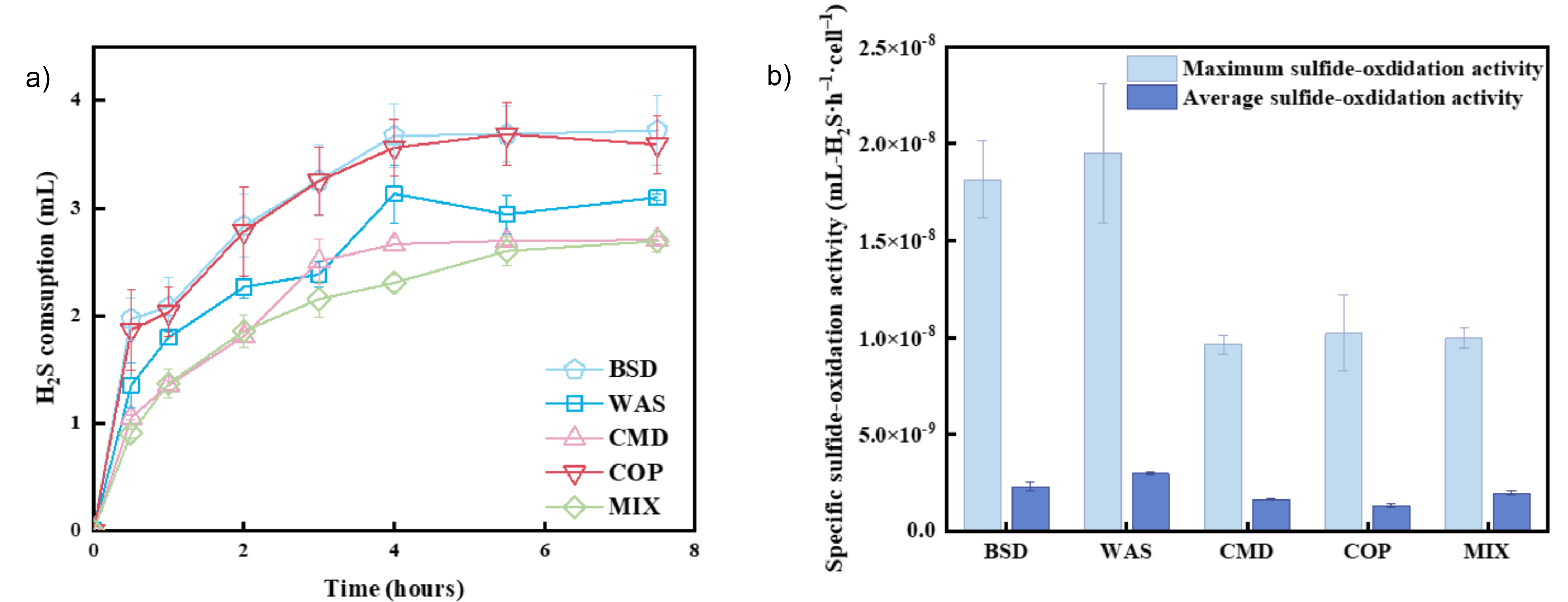


Figure 2: Activity of SOB from different environmental samples. (a) H₂S consumption. (b) Maximum specific sulfide-oxidation activity.

3. Performance of SOB cultured on centrate

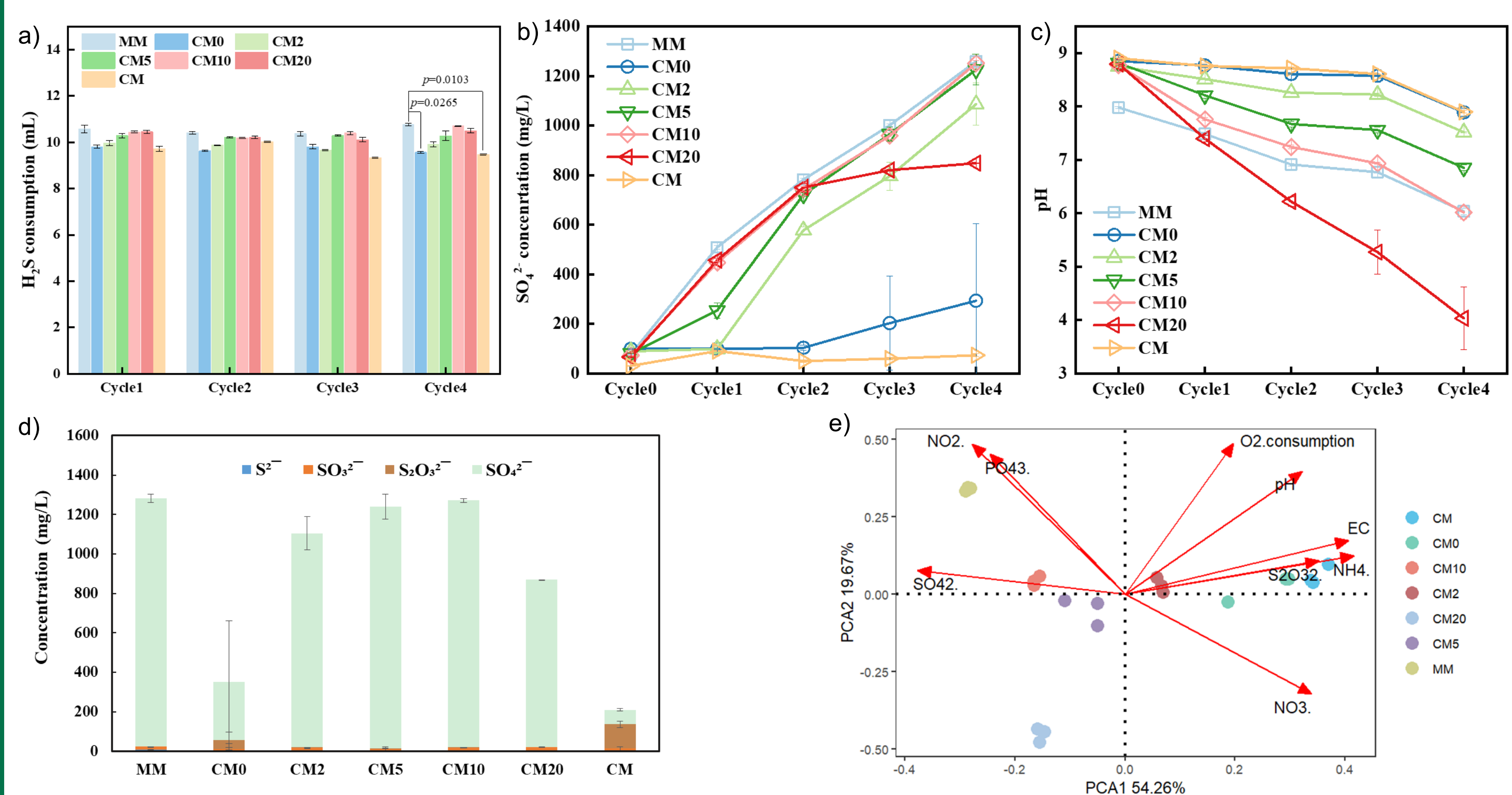


Figure 3: Performance of SOB cultured on centrate: (a) H₂S consumption, (b) SO₄²⁻ production, (c) pH variation, (d) sulfur components in the liquid fraction during cycle 4, and (e) principal coordinates analysis (PCA) of SOB growth performance on centrate.

- The centrate at 2x, 5x, 10x, and 20x dilution can be an alternative culture medium for SOB.
- CM0 and CM remove H₂S via non-biological removal.
- The digestate provided a certain buffering capacity and helped prevent a rapid drop in pH.
- NH₄⁺ showed a **negative correlation with SO₄²⁻** and a **positive correlation with S₂O₃²⁻**.

4. Competition of indigenous bacteria in centrate

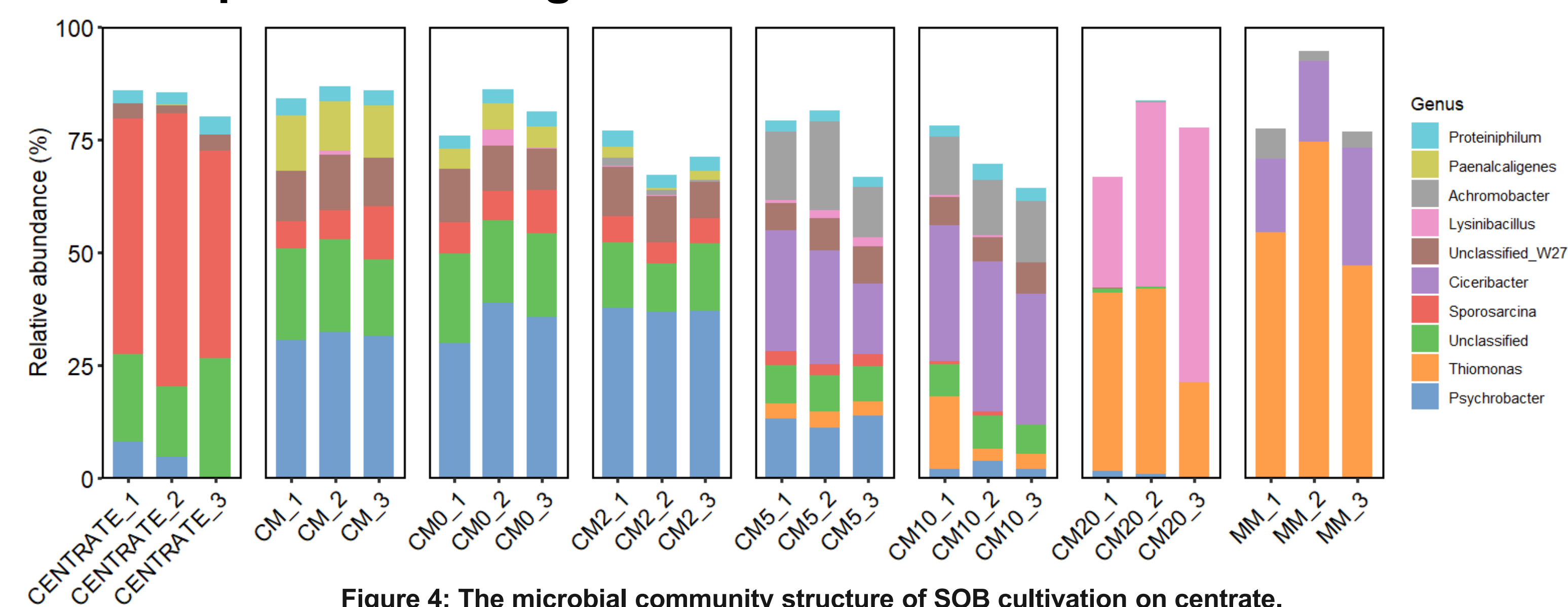


Figure 4: The microbial community structure of SOB cultivation on centrate.

- The **native community** in CM, CM0, CM2 **dominated** during cultivation rather than SOB.
- **CM5 and CM10** formed more stable and balanced microbial communities compared to the MM.

RESULTS :

1. Enrichment of mixed sulfide oxidizing bacteria

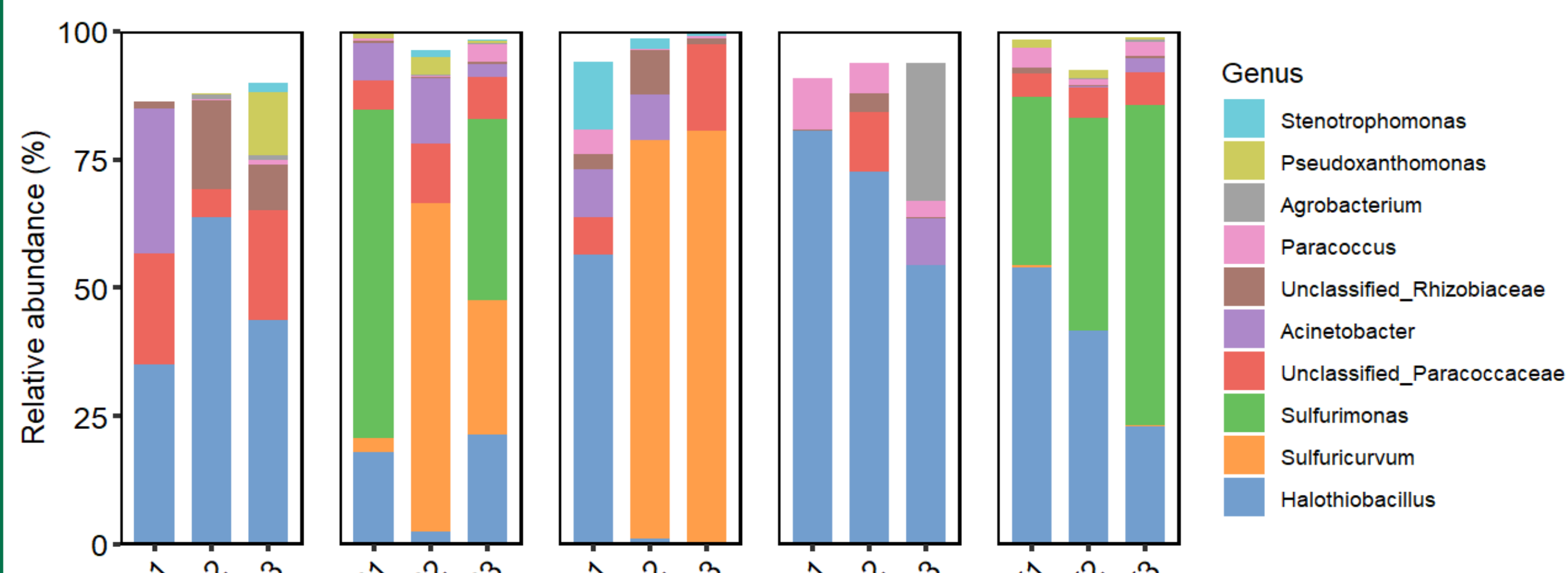


Figure 1: Microbial community of mixed sulfide oxidizing bacteria from different inocula.

- **Halothiobacillus**, with ability of oxidizing thiosulfate through aerobic respiration.
- **Sulfuricurvum**, a facultatively anaerobic and chemolithoautotrophic SOB.
- **Sulfuricurvum** exhibited a competitive disadvantage when coexisting with **Halothiobacillus** and **Sulfurimonas**.

CONCLUSION:

Sulfide-oxidizing bacteria were successfully enriched from four environmental sources, with bio-sludge and waste activated sludge exhibiting the highest sulfide-oxidation activity. At elevated NH₄⁺ concentrations, H₂S removal was predominantly abiotic. SOB sustained stable long-term growth in centrate (2-10x dilution), whose buffering capacity mitigated rapid pH decline. These results demonstrate that cow manure digestate can replace conventional mineral media for SOB cultivation in biological desulfurization systems.