

# Analisis Keberadaan Gen Resisten Terhadap Antibiotik pada IPAL Permukiman di DKI Jakarta dengan Metode High-Throughput qPCR (HT-qPCR) = Analysis of the Existence of Antibiotic Resistance Genes in Tenement WWTPs in DKI Jakarta Using the High-Throughput qPCR (HT-qPCR) Method

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## Abstrak

Provinsi DKI Jakarta umumnya mengandalkan tangki septik di perumahan dan IPAL permukiman di kawasan tertentu sebagai tempat pembuangan tinja setempat serta membuang cairan efluennya ke saluran drainase, tetapi penelitian mengenai kinerja penyisihan unsur AMR-nya masih minim. IPAL permukiman sebagai salah satu sistem pengolahan tinja setempat menciptakan kondisi yang kondusif bagi terjadinya akuisisi resistensi antarinang via transfer gen horizontal (HGT) berdasarkan kelimpahan nutrisi, kelimpahan mobile genetic elements (MGE) yang memfasilitasi HGT, proses pengolahan, kandungan logam berat sebagai tekanan selektif, dan variabel lain-lain. Dengan demikian, penelitian ini dilakukan untuk menganalisis prevalensi ARG dan MGE dengan metode High-Throughput Quantitative Polymerase Chain Reaction (HT-qPCR), tingkat reduksi atau peningkatan ARG dan MGE, serta hubungan antara logam berat dan MGE dengan ARG di IPAL permukiman. Sebanyak 8 dari 65 gen target masih terdeteksi di semua sampel unit final ( $n = 8$ ). Salah satunya adalah crAss56 yang mengindikasikan bahwa efluen cairan IPAL permukiman menjadi potensial sumber diseminasi AMR di hilir. IPAL permukiman tidak menunjukkan kemampuan reduksi kelimpahan absolut gen 16S rRNA, MGE, ARG yang konsisten, bahkan salah satunya (ST4) mengamplifikasi semua gen-gen tersebut. Terlihat pola kelimpahan ARG berbeda antara IPAL permukiman terindikasi terbengkalai dengan yang beroperasi yang menyiratkan mekanisme pengolahan tertentu, seperti pengolahan biologis (aerobik, anaerobik, kombinasi) dan klorinasi, dapat berkontribusi dalam proliferasi ARG. Analisis korelasi Spearman menunjukkan korelasi signifikan secara statistik ( $p$ -value  $< 0.05$ ) dengan arah positif antara mangan (Mn) vs. ARG ( $qacE1\_3 > aph3$ -ib  $> ereA$ ), seng (Zn) vs. ARG ( $aph3$ -ib  $> vanA > ereA > blaSHV11 > intl3 > qnrS2$ ), serta MGE ( $intl3$ ) vs. ARG ( $ereA > vanA > aph3$ -ib  $> blaSHV11 > qacE1\_3 > qnrS2$ ). Maka, korelasi tersebut menandakan  $intl3$  memiliki potensial tinggi sebagai fasilitator HGT. Logam berat juga mungkin menginduksi HGT dan/atau menyeleksi dengan antibiotik secara bersamaan terhadap ARB. Maka, penemuan penelitian ini menyiratkan pentingnya diadakannya pemantauan AMR di berbagai sistem air limbah, khususnya black water.

.....The DKI Jakarta Province generally relies on septic tanks in residential areas and tenement wastewater treatment plants in certain areas as on-site feces disposal sites along with discharging their effluent water into drainage channels, but research on their AMR element removal performance is still limited. Tenement WWTPs as one of the on-site feces treatment systems create conditions that are conducive to the acquisition of resistance between hosts via horizontal gene transfer (HGT) based on the abundance of nutrients, the abundance of mobile genetic elements (MGE) which facilitate HGT, treatment processes, heavy metal content as selective pressure, and other variables. Thus, this research was conducted to analyze the prevalence of ARG and MGE using the High-Throughput Quantitative Polymerase Chain Reaction (HT-qPCR) method, the level of reduction or increase in ARG and MGE, as well as the relationship between

heavy metals and MGE and ARG in tenement WWTPs. A total of 8 of the 65 target genes were still detected in all final unit samples (n = 8). One of them was crAss56 which indicated that tenement WWTP effluent water is a potential source of downstream AMR dissemination. Tenement WWTPs did not show a consistent ability to reduce the absolute abundance of 16S rRNA, MGE, ARG genes, in fact one of them (ST4) amplified all of these genes. It can be seen that the pattern of ARG abundance is different between tenement WWTP indicated to be abandoned and those that are operational, which implies that certain treatment mechanisms, such as biological treatment (aerobic, anaerobic, combined) and chlorination, can contribute to the proliferation of ARGs. Spearman correlation analysis showed a statistically significant correlation (p-value < 0.05) in the positive direction between manganese (Mn) vs. ARGs (qacE $\hat{1}$ \_3 > aph3-ib > ereA), zinc (Zn) vs. ARGs (aph3-ib > vanA > ereA > blaSHV11 > intl3 > qnrS2), as well as MGEs (intl3) vs. ARGs (ereA > vanA > aph3-ib > blaSHV11 > qacE $\hat{1}$ \_3 > qnrS2). Therefore, this correlation indicates that intl3 has high potential as a facilitator of HGT. Heavy metals may also induce HGT and/or co-select against ARBs with antibiotics. Thus, the findings of this study highlight the importance of monitoring AMR in various wastewater systems, especially black water.