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CORSO DI DOTTORATO DI RICERCA (CICLO 35) IN:
SCIENZE E BIOTECNOLOGIE AGRARIE

ANAEROBIC DIGESTION FOR WASTE MANAGEMENT AND ENVIRONMENTAL IMPACT CONTROL OF MARINE FISH FARMS WITH RENEWABLE ENERGY PRODUCTION

Keywords: Aquaculture, anaerobic digestion, biogas, biomethane, fish farm effluents, brackish and marine wastewater, salinity, sludges, anaerobic filter.

Fig. 1 The anaerobic bioreactor simulator

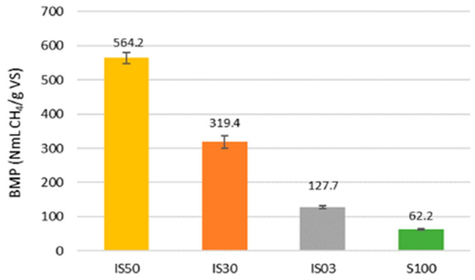
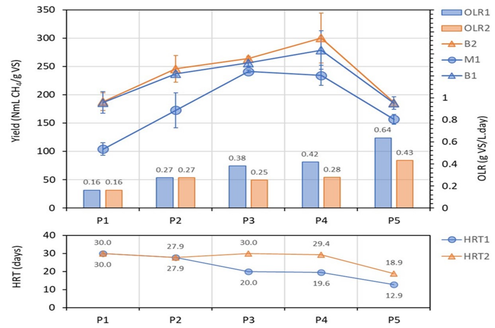


Fig. 2 The biochemical methane potentials of fish farm effluents

AIMS: This work focuses on improving the sustainability of marine aquaculture farming by applying the anaerobic digestion (AD) of farm effluents. Through AD of organic residues, it is possible to produce biogas and biomethane, renewable energy sources, and contemporary reducing the negative environmental impact of intensive fish farming.

APPLICATIONS: initially, the biochemical methane potentials (BMP) of effluents were determined in an automatic methane potential system (AMPTS, Bioprocesscontrol, Sweden), adopting a standard anaerobic inoculum and different ratios between inoculum and substrate (I/S). A second experimental phase was performed with effluents characterized by different salinity in a bioreactor simulator system (BRS, Bioprocess Control, Sweden - Fig. 1) to establish the optimal operating parameters for anaerobic process implementation on a real scale (ie. hydraulic retention time, HRT, and specific organic loading rate, OLR). Lastly, we tested a new prototype of bioreactor layout for the treatment of diluted and high-salinity aquacultural substrates consisting of an up-flow anaerobic floating filter (UAFF).

RESULTS: Fish farm effluents showed a considerably high methane potential (BMP): the highest I/S ratio (IS50) showed the highest BMP (564.2 NmL CH_4/g VS, - Fig. 2), while decreasing BMP values were obtained corresponding to the lower amount of inoculum (319.4 and 127.7 NmL CH_4/g VS, respectively for IS30 and IS03 - Fig. 2). In the continuous anaerobic process simulation, the marine effluents (salinity 35 g/L) had the lowest performance, with an average yield equal to 172.4 NmL CH_4/g VS - Figure 3, compared to the brackish effluent (227.4 NmL CH_4/g VS and 235.0 NmL CH_4/g VS, with salinity 10-13 g/L - Fig. 3). The new prototype of UAFF reactor showed significantly higher yields compared to conventional CSTR reactor during the starting phase of anaerobic digestion, reaching 188 NmL CH_4/g VS compared to 100 NmL CH_4/g VS, respectively - Fig. 4.



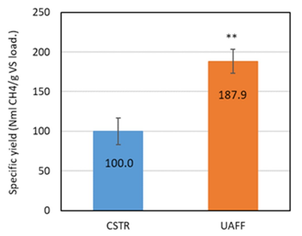


Fig. 4 Biomethane yields of two types of reactor during start-up

Fig. 3 Biomethane yields of marine and brackish effluents