# Solid anaerobic digestion of pig manure with dry and fresh food waste

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## 1. Introduction

Anaerobic digestion (AD) combined organic waste remediation with energy production (biogas) and nutrient recovery (digestate). According to the literature solid – state anaerobic digestion is the best way to treat waste with high solids concentrations (>15%). Although batch dry anaerobic digestion is a well-established technology there are some parameters such as inoculum to substrate ratio, feedstock composition and size of feedstock materials which need further investigation in order to avoid process instability (Karki et. al., 2021). During our experiment, batch reactors were used for anaerobic digestion of pig manure and food waste. The inoculum used in the experiment was dehydrated anaerobic sludge originated from an anaerobic digester located at Wastewater Treatment Plant in Heraklion. The designed batch reactors are equipped with stirring system to treat materials with a humidity of approximately 80%.

## 2. Materials and methods

*2.1. Raw materials, substrates and inoculum*

Food waste (FW) used as a feedstock in our experiment, was collected from the students' restaurant at the Hellenic Mediterranean University, Heraklion. The FW composition was 65% cooked meals, 15% bread and bakery and 20% vegetables and salads (on a wet-weight basis). FW was homogenized using a mechanical mixer (approximately 4.0 mm). Solar drying process was used in order to dehydrate fresh food waste and produce dried material. Inoculum was obtained from an anaerobic digester located at Wastewater Treatment Plant in Heraklion, Greece (population about 200,000). The feed mixture consisted of pig manure 50%, 10% food waste and 40% dehydrated anaerobic sludge.

*2.2. Anaerobic digestion experiment*

At the beginning of the experiment all reactors were inoculated with dehydrated anaerobic sludge from the anaerobic digester of Wastewater Treatment Plant of the city of Heraklion. For the experiment, 5 L lab – scale batch reactors were used, equipped with stirring system on the top cover of the reactor. The laboratory anaerobic bioreactors were constructed of stainless steel, with a water jacket and an outer insulation jacket, operated under mesophilic conditions (37 ± 2 ºC). Anaerobic conditions were achieved using gas mixture of nitrogen and carbon dioxide (70% and 30% respectively) which was flushed immediately after the addition of inoculum and substrates. All reactors have working volume of 4 L and a residence time of 60 days.

2.3. Analytical Methods

The pH was analyzed according to (APHA, 2005) using a pH-meter (model GLP21, Crison). Solid Chemical oxygen demand (sCOD) were determined according to APHA 5220D. Total (TS) and volatile (VS) solids were measured gravimetrically and total nitrogen (TN) was measured with Semi – Micro – Kjeldahl Method according to APHA (2005). The total organic carbon (TOC) of the materials was analyzed using a TC/TN analyzer with a solid sample module (TOC-V, SSM-5000A, Shimadzu, Japan). Biogas content was analyzed using a Gas Chromatograph (Agilent 6890 N) equipped with a TCD detector and an appropriate capillary column (GS Carbon plot, 30 m x 0.32 mm).

## 3. Results and Discussion

In order to produce biogas by solid state anaerobic digestion, pig manure and food waste (fresh and dry) were employed in this research. The research was conducted in laboratory anaerobic bioreactors with a total volume of 5 L. Different mixtures of fresh food waste, dry food waste, and pig manure are the materials employed in the reactors. The reactors were conducted with a 60-day HRT in mesophilic conditions (37 ºC). The biogas production rate ranged from 0.5 $L_{biogas}/L_{reactor}$/d to 1.0 $L_{biogas}/L_{reactor}$/d. Regarding volatile solids the reduction ranged between 30% to 35%. These findings demonstrated the great potential for converting agricultural waste and food waste into sustainable energy sources utilizing solid anaerobic technology.

**References**

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