

Anaerobic biodegradability of typical organic agro-wastes in Western Greece.

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Agro-industries namely slaughterhouse facilities, pig, cow and poultry breeding farms represent a considerable share of the Western Greece economy. High-strength complex wastewaters from abattoirs contain significant amounts of coarse suspended organics emanating mainly from offal and bones. Cow, pig and poultry breeding wastes are characterized by high organic content with high amounts of total solids, ammonia and pathogens. Insufficient or uncontrolled handling and disposal of such highly polluting agro-wastes encounter imminent danger to environment and thus to public health. Moreover, agricultural carbohydrate-rich residues, e.g. vegetables (eggplants, zucchinis etc), fruits (oranges, pears etc) and seagrass biomass, such as naturally washed up seagrass, are currently disposed of in the open environment without any prior treatment or recovery of their contained nutrients or energetic content. Anaerobic digestion of agro-industrial wastes is considered as the most promising biological process for treatment of high organic content wastes providing benefits such as pollution control, odour and pathogen level reduction, nutrient recovery and energy production. Hence, biodegradation of organic wastes and residues results into both pollution prevention and recovery of sustainable energy (i.e. biogas). To this end, fermentable carbohydrate-rich and starch-rich agro-wastes are suitable substrates for biological conversion to methane. Biochemical methane potential (BMP) is an experimental procedure developed to determine the methane production of a given organic substrate during its anaerobic decomposition. The BMP assay has proved to be a relatively simple and reliable method to obtain the extent and rate of organic matter conversion to methane (Owen et al., 1979).

The aim of this study was to estimate the methane potential of different types of agro-wastes from the Region of Western Greece using the BMP assay. A variety of organic substrates was chosen according to their regional availability in Western Greece. Four types of manure, including cow (CM), pig (PM), sheep (SM), poultry manure (PoM), were obtained from the Regional Entity of Arta. Dried (at 55 °C) manure was gently ground with an agate mortar and pestle, and sieved (with size fraction 125-315 µm). Slaughterhouse waste (SW), which consisted of intestines of bovine, soft offal and bones, was collected from a pig/ lamp slaughterhouse located in the Regional Entity of Preveza. Additionally, fruits and vegetables included oranges (OR) from the Regional Entity of Arta, eggplants (EG), zucchinis (ZU), pears (PE) and potatoes (PO) from the Regional Entity of Preveza and also grape marcs from wineries and distilleries (GMW and GMD, respectively) located in the regional entity of Achaia. Finally, naturally washed up seagrass (SG) of *Posidonia Oceanica* was collected with an environmental-friendly way (in order to protect the beach) from the selected shore of Mitikas, Preveza. *Posidonia oceanica* (L.) forms single species meadows and is the dominant seagrass species in the Mediterranean littoral zone. Raw solid substrates such as SW, solid fruits and vegetables, grape marcs (GMW and GMD) and SG were minced (2-5 mm), homogenized using a kitchen blender (Izzy E450 Multi Plus with Double "Quad" Blade) and then subjected to freeze-drying process (using a LyoQuest - Telstar) and finally pulverized (with particle size 125-315 µm apart from SW: 315-710 µm).

Laboratory-scale BMP assays of the collected substrates were conducted with acclimated methanogenic anaerobic sludge. Each substrate was used in duplicate, whereas two additional bottles containing only inoculum were included to account for background (i.e. endogenous) methane production. Briefly, known amounts of substrate and active anaerobic inoculum were added to 160-mL serum bottles. Additional defined media containing nutrients and vitamins for mixed anaerobic cultures were also added (Owen et al., 1979). The serum bottles were flushed for 5 min with nitrogen gas and then sealed immediately using butyl rubber septum and aluminum crimp caps. Once sealed, the bottles were placed in an orbital shaking water bath (Grant OLS200) at 80 rpm and maintained at a constant mesophilic temperature (37°C).

Prior to BMP experiments, a physicochemical composition analysis for each one of the different waste samples was performed. All tested substrates were characterized by high concentration of organic matter. Grape marcs from wineries (GMW) were characterized by the highest organic content (129 g COD/ g DM), whilst slaughterhouse waste (SW) contained also a high organic content (110.34 g COD/ g DM) with low carbohydrate content (0.87 g eq. glucose/ g DM) among other wastes. On the contrary, oranges (OR) and pears (PE) contained the highest both total (73.48 and 63.05 g eq. glucose/ g DM) and soluble carbohydrate content (68.02 and 63.52 g eq. glucose/ g DM), whereas high concentration of total phenols was analyzed in the grape marcs from distilleries (GMD) (3.77 g syringic acid/ g DM).

Finally, pig (PM) and poultry (PoM) manure contained high amounts of phosphorus (2.08 and 2.03 g/g DM, respectively).

Biogas and methane production were monitored throughout the experimental period (100 days). Methane production started immediately in all samples without noticeable lag-phase. The methane yields for all tested substrates (presented in Fig. 1) ranged between 162.92 and 732.58 mL CH₄/ g VS added. The methane volume produced from each sample was corrected by subtracting the mean methane volume of the inoculum (control) and converted to standard temperature and pressure (i.e. STP = 0 °C and 1 atm). The highest methane yield was obtained for slaughterhouse waste (SW) (732.58 mL CH₄/ g VS added), while the lower yields were measured using grape marcs (both GMW and GMD).

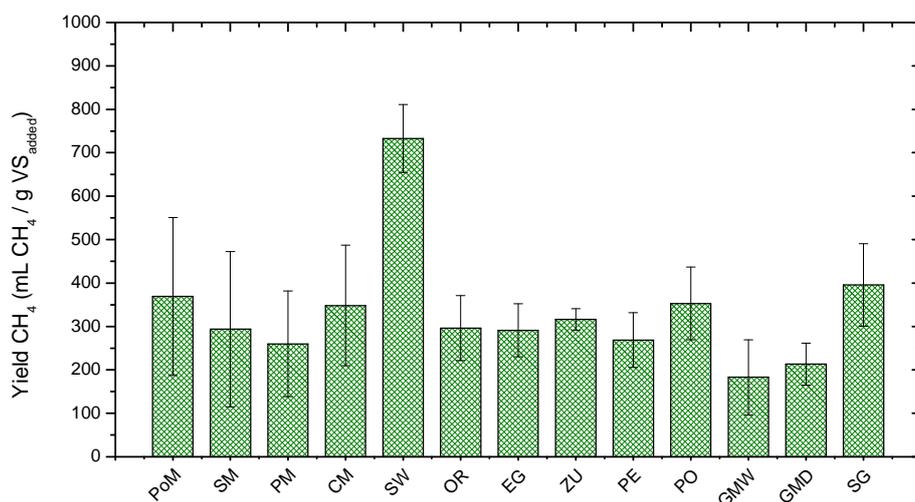


Figure 1. Calculated methane yield of selected agro-wastes from Western Greece Region.

References

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