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Biochemical methane potential of raw and pre-treated meat-processing wastes

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HIGHLIGHTS

- ▶ Biochemical methane potential (BMP) of pre-treated greaves and rinds were studied.
- ▶ BMP of rinds was improved 25% by exposure to 70 °C for 24 h.
- ▶ Incomplete hydrolysis of rinds caused inhibition of methanogens in the BMP assays.
- ▶ For greaves, hydrolysis was the limiting step even after the applied pre-treatments.

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ABSTRACT

Raw and pre-treated greaves and rinds, two meat-processing wastes, were assessed for biochemical methane potential (BMP). Combinations of temperature (25, 55, 70 and 120 °C), NaOH (0.3 g g^{-1} waste volatile solids) and lipase from *Candida rugosa* (10 U g^{-1} fat) were applied to promote wastes hydrolysis, and the effect on BMP was evaluated. COD solubilisation was higher (66% for greaves; 55% for rinds) when greaves were pre-treated with NaOH at 55 °C and lipase was added to rinds after autoclaving. Maximum fat hydrolysis (52–54%) resulted from NaOH addition, at 55 °C for greaves and 25 °C for rinds. BMP of raw greaves and rinds was 707 ± 46 and 756 ± 56 L CH_4 (at standard temperature and pressure) kg^{-1} VS, respectively. BMP of rinds improved 25% by exposure to 70 °C; all other strategies tested had no positive effect on BMP of both wastes, and anaerobic biodegradability was even reduced by the combined action of base and temperature.

1. Introduction

Slaughterhouses and meat processing industries generate large amounts of wastes and by-products, e.g. carcasses, feet, offal, hides, bones and blood, corresponding to 40–50% of the total animal weight slaughtered (Cuadros et al., 2011; FAOSTAT, 2012). Anaerobic digestion of organic wastes is a highly sustainable process, since it combines waste treatment with energy production in the form of biogas and nutrients recycling. Animal wastes are typically rich in fats and proteins (Salminen and Rintala, 2002), therefore representing a good substrate for biogas production. However, the conversion of these complex particulate materials to methane in anaerobic digesters is frequently limited by the hydrolysis step (Masse et al., 2003; Vavilin et al., 1996). Efficient hydrolysis is crucial to make complex substrates accessible to anaerobic bacteria and ultimately optimize methane production.

Several pre-treatment techniques have been applied to enhance hydrolysis and anaerobic biodegradability of organic wastes (Cammarota and Freire, 2006; Carrère et al., 2010; Costa et al., 2012; Hejnfelt and Angelidaki, 2009; Luste et al., 2009). Physical treatments such as high temperature, microwaves, ultrasounds, grinding and maceration destroy aggregated particles, decrease particles size and disrupt cell structure. The molecular structure of the material can be changed through the addition of acids or bases, or through the action of enzyme-producing microorganisms (bioaugmentation) or enzyme preparations. The majority of the studies have been focused on pre-treating waste activated sludge or wastewaters (Bougrier et al., 2008; Cammarota and Freire, 2006; Carrère et al., 2010; Masse et al., 2003; Valladão et al., 2007; Zhang and Jahng, 2010), and only few authors tested this approach on animal wastes (Table 1).

In most cases the hydrolysis of the wastes is not complete and only partial solubilisation of the materials or particle size reduction is achieved. Additionally, methane production from the hydrolysates is not always higher than that obtained from untreated wastes, and in some cases it even decreases (Costa et al., 2012;

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