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ANAEROBIC DIGESTION OF SUGAR BEET PULPS

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SUMMARY

Anaerobic digestion of sugar beet pulps was studied in a 70 l digestor with sequential feeding, after enzymatic hydrolysis by Trichoderma harzianum cellulases. During the 130 days feeding, 3.6 m^3 of biogas were produced with an average content of 58 % CH_4 from 270 l of hydrolysed pulps at 20 g VS/l. Average yield and production rate were respectively 0.67 m^3/kg VS and 0.4 m^3/ kg VS and 0.4 m^3/m^3 of digestor per day.

INTRODUCTION

Bioconversion of agro-industry cellulosic by-products is promising for proteins, enzymes, alcohol or biogas production. Sugar-beet by-products are diversely used: yeasts and various metabolites are obtained from molasses, pulps are used for complementation in animal feeding after ensilage.

Several assays have been made to produce cellulolytic enzymes from pulps by culture of moulds in liquid (CONTRERAS et al., 1982; ROUSSOS et al., 1983) or solid media (ROUSSOS et al., 1983).

We used the culture method of fungal growth in solid state fermentation as described by RAIMBAULT and ALAZARD (1980) to produce cellulases by a strain of Trichoderma harzianum. The enzymes obtained were used to hydrolyse pulps before anaerobic digestion.

MATERIALS AND METHODS

1. Microorganism : the organism used for the production

was performed at 50°C for 60 h with continuous mixing. At the end, the whole pulps were liquefied and stored in a deep freezer before utilization.

4. Methanogenic fermentation of solubilized pulps : Anaerobic digestion of hydrolysed pulps was conducted in a 70 l digestor. The 35°C temperature control was obtained by circulation of regulated water in an outside jacket. Intermittent recycling of the digestor contents was made by a pump.

The digestor was inoculated with a mixture containing: swine waste 30 l, fermented manure 30 l, fermented swine waste 5 l and water 5 l. The addition of hydrolysed pulps started only at the end of gas production by this initial mixture.

Introduction of solubilized pulps was made once or twice a day by replacing equal volume of digestor juice content.The V.S. content has been increased in a range of one to four during the 18 weeks of fermentation. From threefold increase, loading was performed twice a day.

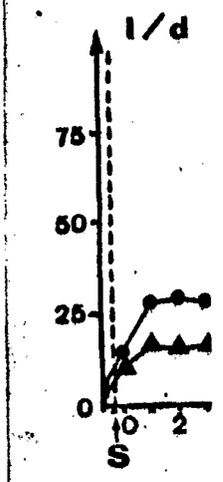
5. Methods of analysis : gas production was measured with a gasmeter and automatically analysed by thermal conductivity with a gas chromatograph (GIRDEL 30) according to the calibration described by GARCIA et al.(1982). Volatiles fatty acids (VFA) were analysed as previously described (GARCIA et al.,1982). The pH value of the digestor contents was followed all along the anaerobic digestion.

RESULTS

During the early 13 weeks, sequential feeding was made with 2 l a day of solubilized pulps (20 g VS/l). Then an increasing dayly load was applied every 2 weeks until it reached four times the initial load. At the end of the experiments, feeding was performed with fermented solubilized pulps in order to observe effects on methanogenesis.

During the 18 weeks of fermentation, the digestor produced 3.617 m^3 of biogas with an average content of 58% CH_4 from 270 l of hydrolysed pulps. Total gas yield was 0.67 m^3/kg VS with an average production rate of 0.4 m^3/m^3 of digestor per day.

As shown in Fig.1, the weekly production of biogas reached a constant value after 1.5 weeks loading time and maintained its rate over the 13 weeks at the same daily load. When double feeding was applied, the gas production increased three times and maintained its rate despite of the next increase of loading. When fermented pulps were added after 18 weeks of fermentation, the gas production decreased dramatically.



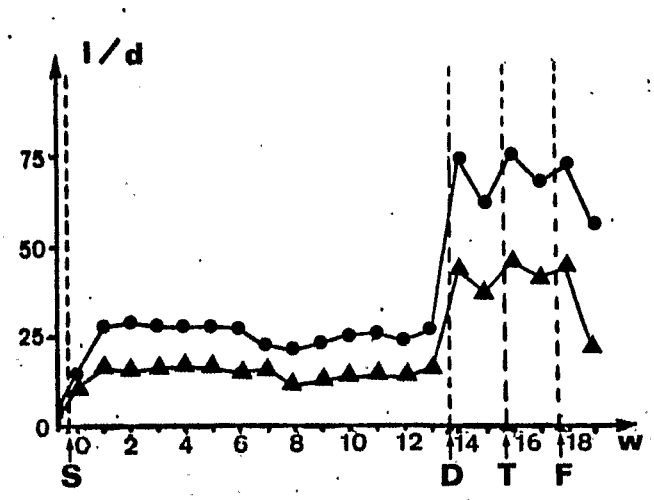


Fig.1- Weekly average production of biogas ● and CH_4 ▲

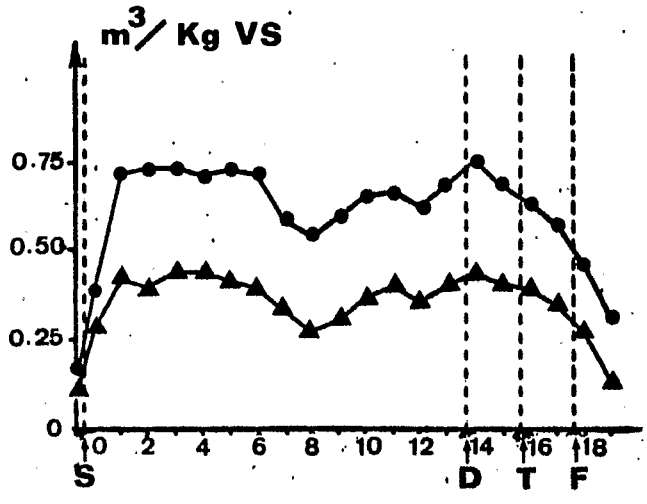


Fig.2- Weekly average yield of biogas ● and CH_4 ▲

S = simple charge loading

D = double charge loading

T = threefold charge

F = fourfold charge

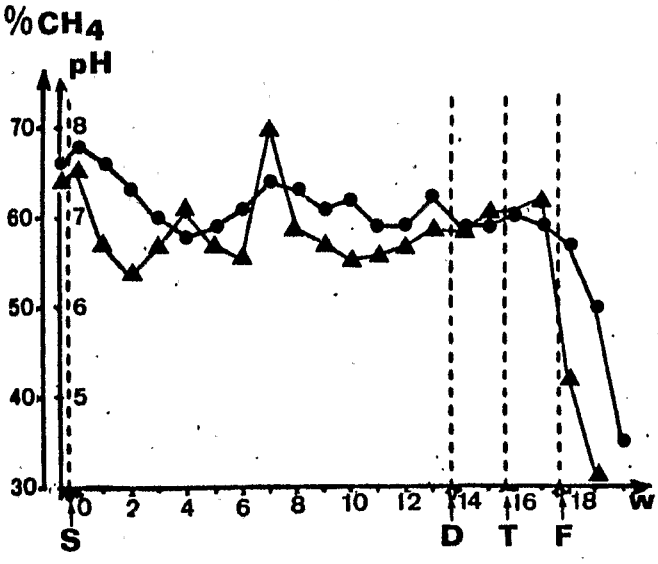


Fig.3- Weekly variations of pH ● and CH_4 evolution ▲ during anaerobic digestion of prehydrolysed sugar beet pulps.

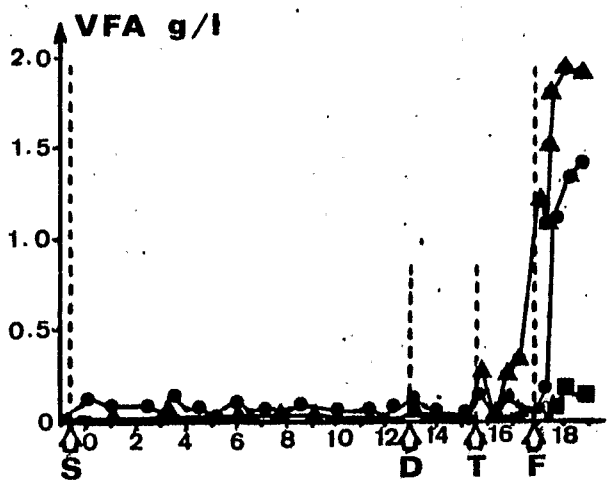


Fig.4- Weekly average production of volatile fatty acids: acetic ● ;propionic ▲ ; butyric ■ .

(NYNS, 1979). Other results obtained with sugar beet pulps by LESCURE (1982), without pretreatment, showed that 88% of the carbon content were digested over 96 days in a 25 m^3 digestor by a two stages digestion.

In our experiments, the best conditions to methanize solubilized pulps seem to be : average loading 1 kg VS/m^3 per day, hydraulic retention time 17 days, gas production 1 m^3/m^3 per day, gas yield 0.74 m^3/kg VS. Enzymatic hydrolysis of pulps releases a lot of metabolizable sugars from cellulose and probably from hemicelluloses and pectines. Given these considerations, the suitable COD loading is not allowed to be as high as for crude substrates. However, biological pretreatment widely increases the susceptibility of carbon, which explains the high yield obtained.

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