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A study on the efficiency of whey water pretreated Parthenium hysterophorus L. as potential feedstock

KEYWORDS: Biomethanization, Whey water, Pretreatment, Parthenium hysterophorus.

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ABSTRACT *Among several technologies the anaerobic digestion technology has been proved to be viable and emerged as a promising technology in India, as it requires less capital investment and per unit production cost, as compared to other renewable energies. Mass utilization of Parthenium hysterophorus biomass and environmental friendly synthesis of bioproduct-methane which is of high demand through a biomethanization is a promising approach. Biogas, a product of biomethanization process of organic substrate carried out by a consortium of microorganisms and depends on various factors like pH, temperature, C/N ratio, hydraulic retention time etc. Thus, there is a need to improve the overall efficiency of anaerobic digestion process in the biogas plants. This could be achieved by optimizing several methods such as the various operational parameters, the nutritional requirements of microbes, the pretreatment protocols, the feedstock proportions etc. Crop biomass mainly consists of cellulose, hemicelluloses and lignin, which act as limitating factors in the process of methanation. Therefore, need for pretreatment protocols to remove the various limitations and to achieve optimized gas production are dealt in the present study. The general process of applying pretreatment is to increase biodegradability and bioavailability of digested materials thus enhancing biogas production in further anaerobic process. For pretreatment of certain type of biomass, the choice of pretreatment technique has to be more efficient both in terms of economical and environmental aspects. Pretreatment has been recognized as one of the most expensive processing steps in conversion of cellulosic biomass to fermentable sugars and at the same time a very crucial step for the biological conversion of plant source into methane. The overall goal of the pretreatment routes being designed and developed is to convert the plant's raw lignocellulosic sugars in an environmentally sustainable way. Thus in this study, the feasibility of utilizing Parthenium as potential feedstock was examined by using whey water pretreatment protocol. The results obtained with respect to that of C/N ratio, C/P ratio, lignin and holocellulose showed a significant change when compared to the untreated Parthenium biomass.*

Introduction:
In this age of renewable energy, there is an ever rising demand for the alternative energy source which calls for exploring and exploiting new sources of energy. On the other hand, the effect of weed on the agricultural soil is of paramount importance. In India, being the developing country, to meet the demand of this alternative energy source and to minimize the agricultural loss caused by weeds, various eco-friendly methods were been adapted in the past. Biomethanation being the sought after technique, this study aims addressing at both these issues simultaneously. *Parthenium*, being declared as one among the top ten noxious weed of India, pose a very serious threat to the agricultural yield, thus affecting the country's economy (Tefera, 2002). On the other hand, dairy wastes with high organic matter are produced in abundant. The disposals of this dairy effluent too pose serious environmental pollution (Demirel. B., et. al., (2005), Gavala. H. N.., et. al., (1999), Kalyuzhnyi. S. V., et. al., (1997)). Though anaerobic digestion of cheese whey offers an excellent solution, is not extensively used due to the problem of slow reaction, increase in hydraulic retention time (HRT) and rapid acidification (Chen. Y., et. al., (2008), Elmitwalli. T. A., et. al., (2007), Gannown. H., et. al., (2008), Michaud.S., et. al., (2002), Najafpour. G. D., et. al., (2006), Zinatizadeh. A. A. L., et. al., (2006)). This was addressed by novel hybrid systems. Various studies were made in past in combining the substrates to achieve a suitable inoculums substrate (I/S) ratio for the substantial biomethanation process. In this study the rapid acidification process which posed a problem with anaerobic digestion of cheese whey is positively used as pretreatment methodology for optimizing the *Parthenium* weed as potential feedstock. The *Parthenium* weed management and disposal of diary effluent is thus addressed in a safer and economic way.

Materials and methods:
Processing of Parthenium for experiment:
Parthenium hysterophorus weed, used in this study was collected in Hesaraghatta, Bangalore. The plant when collected was in the flowering stage. The entire plant was carefully uprooted and was thoroughly washed under running tap water. Later the long stems along with other parts of the plant were cut into small pieces of 4-5inches in length. This was later Sun dried for 12 consecutive days. Then, the finally dried *Parthenium* material (DP) was milled to attain a final particle size of 3-5mm which was stored in closed container at room temperature until used.

Collection of Whey water for pretreatment:
The dried Parthenium (DP) was pretreatment with whey water at the rate of $4mlg^{-1}$ TS at room temperature ($28\pm2^{o}C$) for 144hrs with periodic mixing. The whey water was collected from K.C.Das Pvt Ltd., Bangalore. The initial pH at the beginning time of pretreatment was found to be 4.0 which were neutralized to pH 7.0 at the end of the treatment period. These pretreated samples were refrigerated for further analysis.

Analytical methods:
The untreated (UT) and pretreated (PT) samples were tested for Total Organic Carbon (TOC) by USP – Pg 257,

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TS, N_2, C:N, C:P, Lignin by APHA Standard methods, 1995 and Holocellulose by Roger.M. Rowel, 2012. All computational analysis was done in quadruplicate and data were corrected to a 100% dry matter basis. Since there was only a single sample of plant biomass, statistical analysis of the compositional data was not possible.

Result and discussion:

Characteristics of UT and PT Parthenium biomass:

The pretreatment procedure has led to changes in the physic-chemical characteristics of the plant biomass. The reported results are the mean of four replicates with standard deviation (mean±SD). The probability levels used for statistical significance were $P<0.05$ for the tests. Statistical analysis of the data was carried out with one way analysis of variance (ANOVA).

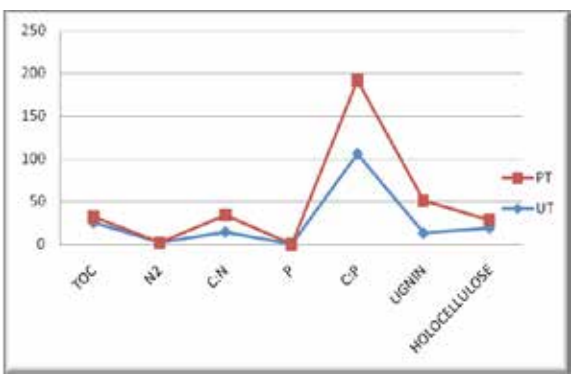

Fig:1 The physico-chemical parameters of UT with that of PT *Parthenium* biomass.

The pretreatment of whey water at the pH of 4 has led to a lot of changes in the physic-chemical parameters of the *Parthenium* biomass is well depicted in Fig: 1. The pH which was a constraint otherwise in the anaerobic digestion process that inhibits the conversion of acids to methane has positively showed an impact in preparing the plant biomass as a potential feedstock.

Conclusion:

Though there are abundant of organic matter present in the weed biomass, most of it was not available to the microbes for better decomposition due to the presence of resistant and protective compounds like lignin and holocellulose. The acid content of the whey water (diary effluent) which was otherwise a critical factor during the anaerobic digestion was tested as pretreatment option. Biomethanation being a sought after technique in weed management this paper has given an insight with whey water pretreatment protocol in making the *Parthenium* weed a potential feedstock. A conclusive result on the pretreatment process and the yield of the methane gas can be well established with further study on processing the biomass for the biomethanation study.

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