EVALUATION OF THE INFLUENCE OF PARAMETERS ON STEAM EXPLOSION PRE-TREATMENT AND ENZYMATIC HYDROLYSIS AT THE PRODUCTION OF ETHANOL FROM SUGARCANE BAGASSE

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INTRODUCTION AND OBJECTIVES

In the current global scenario, the demand for fuels and other chemicals developed from sustainable technologies have become increasingly common, especially in context of biorefinery. Thus, plant biomass emerge as an excellent alternative for presenting wide availability and cost competitive, especially in Brazil, where agricultural residues such as bagasse and straw cane sugar are extremely abundant.

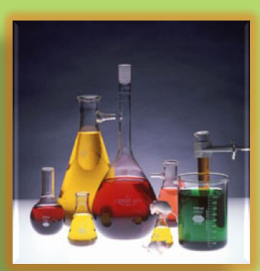
Nowadays the sugarcane is the option of biomass that aggregates greater productivity per unit area and better energy balance, which is the ratio of the outgoing energy in the form of the product (ethanol for example) and fossil energy consumed in production chain (CGEE, 2009).

Lignocellulosic biomass were composed of three major fractions which together make up more than 90% of total dry matter, namely: cellulose, hemicellulose and lignin. The production of ethanol from this biomass comprises the steps of hydrolysis of cellulose, separation of residual lignin, fermentation of sugars present in the hydrolyzate broth obtained, and finally recovering and purifying the ethanol produced (Teodoro et al., 2011).

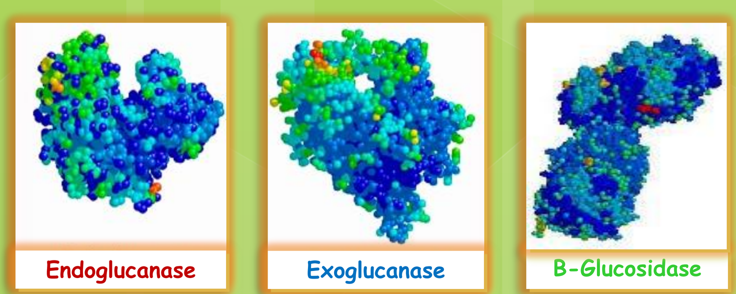
In this study, sugarcane bagasse was pretreated by steam explosion and then subjected to enzymatic hydrolysis in order to produce fermentable sugars. Subsequently, the hydrolysates were fermented by supplementing the medium with glucose and nutrients, in order to verify if the parameters studied at pre-treatment and enzymatic hydrolysis have influence in the overall process production of ethanol from sugarcane bagasse.

MATERIALS

Sugarcane Bagasse
Iracema Mill - Iracemápolis/SP.

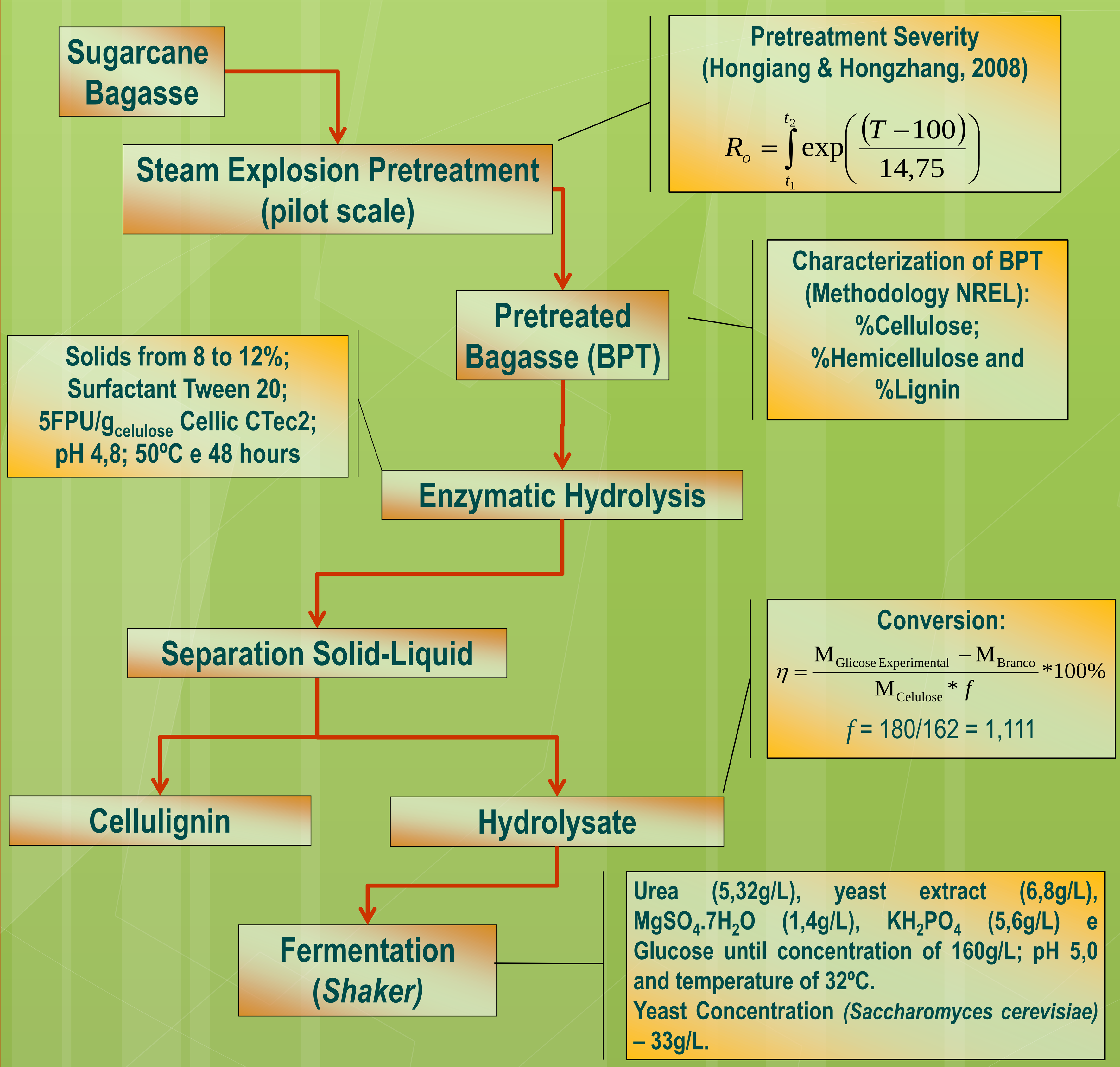


Chemical Reagents P.A.



Enzima Cellic CTec2 - Novozymes - Curitiba/PR.

EXPERIMENTAL METHODOLOGY



RESULTS AND DISCUSSION

STEP 1: Steam Explosion PreTreatment.

Tablel 1 – Severity and conditions of steam explosion pretreatment by in pilot scale.

Sample	Temperature(ºC)	Pressure (kgf/cm²)	t_1 (min)	t_2 (min)	Severity
BPT-A	203,3	17,0	5	8	4,01
BPT-B	203,0	17,0	5	10	4,06
BPT-C	202,2	17,0	3	10	4,05
BPT-D	201,9	17,0	3	12	4,10

t_1: Heating time required for the desired pressure is reached (ramp); t_2: time when the system is under the desired pressure (level).

STEP 2: BPT's Characterization.

Table 2 – Compositional analysis of sugarcane bagasse and steam pretreated bagasse based on the content of insoluble solids.

Sample	Insoluble Solids (%BPT)	Cellulose (%SI)	Hemicellulose (%SI)	Lignin (%SI)
"in natura"	--	40,57	25,09	22,71
BPT-A	75,95	58,32	4,80	31,64
BPT-B	79,64	58,11	4,03	33,04
BPT-C	79,01	58,33	4,81	32,42
BPT-D	81,69	57,83	3,83	33,56

Table 3 – Compositional analysis of steam pretreated bagasse based on the content of soluble solids.

Amostra	Soluble Solids (%BPT)	Glucose (%SS)	HMF (%SS)	Xylose (%SS)	Furfural (%SS)	Acetic Acid (%SS)
BPT-A	24,05	10,84	0,62	58,48	2,65	13,93
BPT-B	20,36	11,94	1,12	49,32	6,39	22,51
BPT-C	20,99	12,88	0,23	58,89	3,13	21,24
BPT-D	18,31	12,39	0,77	45,48	7,69	12,54

STEP 3: Enzymatic Hydrolysis of BPT's.

Table 4 – Conversions obtained in the enzymatic hydrolysis reactions of BPT's with solids content of 8% and 12%, enzymatic load of 5 FPU/gcelulose for 48 hours..

Sample	Conversion (%)			
	8% solids		12% solids	
	24 hours	48 hours	24 hours	48 hours
BPT-A	48,56	69,54	37,43	54,25
BPT-B	41,40	58,77	39,06	54,44
BPT-C	40,25	56,57	35,56	53,10
BPT-D	43,60	60,72	36,28	53,18

STEP 4: Fermentation of Hidrolysates.

Table 5 – Fermentation yields. Initial substrate concentration of 160g/L, run time of 10 hours. Control - Test in the absence of hydrolysate.

Sample	Acetic Acid (g/L)	Glycerol (g/L)	Ethanol (g/L)
BPT-A_12%	0,45	6,61	73,14
BPT-B_12%	0,90	6,40	73,88
BPT-C_12%	0,42	6,41	73,67
BPT-D_12%	1,02	6,73	74,87
BPT-A_8%	0,35	7,25	76,70
BPT-B_8%	0,71	7,20	68,44
BPT-C_8%	1,28	7,22	69,52
BPT-D_8%	1,10	6,82	77,34
Control	2,06	9,08	76,26

CONCLUSIONS

The present results show that concurrent changes in process parameters combined, for example, pre-treatment time (severity), and solids content in enzymatic hydrolysis has influence in the cellulosic ethanol production.

The best combination of pretreatment time was 5 minutes of ramp and 8 minutes of level, where were observed low formation of degradation compounds such as furfural and acetic acid.

The hydrolysis of the four produced BPT's using solids content of 12% achieved cellulose to glucose conversions around 54%. These results are very promising, since chemical catalysts were not used in the pretreatment and, in addition, a low concentration of enzyme was used in the hydrolytic process.

The broths produced in the hydrolysis with 12% TS were fermented simulating the conventional manufacturing process. Could be observed for all fermentations performed similar income to the average obtained for the control experiment.

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Acknowledgments : The authors thanks Novozymes, the Iracema Mill and the CTC.