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PRE-TREATMENT AND HIDROLYSIS OF SISAL SOLID RESIDUE BIOMASS

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1. INTRODUCTION

In Brazil, Agave sisalana (sisal) is cultivated to produce natural fiber, which supplies 40% of the world market (ANDRADE; ORNELAS; BRANDÃO, 2011). Sisal fibers are obtained from the extraction and processing of its leaves, but in this process, a huge quantity of residues is generated corresponding to approximately 95% of the plant's weight (QUEIROGA et al., 2021). Currently, this lignocellulosic residue is not used in an ecological and economical way (CANTALINO; TORRES; SILVA, 2015), thus, there is great economic interest to study a process of chemical valorization of this biomass, adding value to the agave bagasse residues. This study proposes to evaluate the pretreatments physical-chemical and hydrolysis methods for the fermentable sugars production, using sisal bagasse.

2. METHODOLOGY

Initially, the agave residue was dried at 65°C for 120 hours, ground using a knife mill and sieved to a 40 mesh. The in-natura biomass was characterized using the EMBRAPA (2010) method, in sequence, the following pre-treatments were used: solid:liquid ratio (Si) of 1:10 (w/v) with i) H_2SO_4 1.5%(w/v) at 121°C for 30 min; ii) NaOH 3%(w/v) at 120°C for 30 min, iii) H_2O_2 7.5%(w/v) (pH 11) at 50°C for 30 min with agitation; and iv) hydrothermal at 120°C for 30 min.

All pretreated and in-natura solid fractions were hydrolyzed to verify their responses to the pretreatments. The enzymatic hydrolysis was performed in a 25 mL Erlenmeyer flask, adding 1 gram of pre-treated and in-natura biomass, 10 (FPU/g) of cellulase (Celluclast™ enzyme) and completing the reaction volume (10 mL) with buffer solution pH 4.5 (citrate/citric acid), under agitation of 150 rpm at 40°C, for 48 h. The acid hydrolysis was performed in solid:liquid ratio of 2:10 (w/v) with H_2SO_4 1,5% at 121°C for 30 min, in autoclave.

For the determination of reducing sugars (Rs), 3,5-dinitrosalicylic acid (DNS) was used as an oxidizing agent, as described by Miller (1959). Holocellulose conversion (%HcC) of all assays was determined from **Eq.1**:

$$\%HcC = Rs(g.L^{-1}) / [1{,}11 * \frac{\%Hc}{100} * Si(g.L^{-1})] \quad (1)$$

3. RESULTS

The sisal bagasse, in-natura, of this study presented 49.46% concentration of holocellulose (%Hc), alfacellulose (34.78%) and extractives (26.39% of organo-soluble compounds) and lower content of lignin (6.41%). In the pre-treatments the holocellulose concentration (%Hc) obtained was 54.19% in acid, 49.33% in alkaline, 55.25% in the peroxide-alkali and 44.11% in the hydrothermal pre-treatments, used to calculate the conversion rate by the reducing sugars concentration.

Among the chemical pre-treatments used, the acid pre-treatment presented a better response when compared to the alkaline, peroxide-alkali and hydrothermal pre-treatments (**Table 1**). However, it is observed that the enzymatic and acid hydrolysis with in natura biomass, that is, without pre-treatment, present the best response in terms of total reducing sugars produced (about 59.61% and 93.06%,

respectively) demonstrating that there is no need to perform chemical pre-treatments with the studied biomass. The same was observed in the study of Alencar et al. (2018) in which, when working with cactus pear varieties it was shown that the best response in enzymatic hydrolysis was obtained when the biomass was in natura.

Table 1: Conversion of holocellulose in total reducing sugars with pre-treatment and in-natura post hydrolysis

Pre-treatments	Holocellulose conversion (%)	
	After Enzymatic hydrolysis	After Acid hydrolysis
NaOH	2.63±3.33	5.94±5.04
H_2SO_4	51.45±0.75	48.34±6.57
Hydrothermical	41.61±1.49	55.56±2.76
H_2O_2	7.20±1.63	11.53±1.75
In-Natura	59.61±3.00	93.06±2.28

Thus, the two hydrolysis processes with biomass in-natura demonstrate a reduction in the number of steps in the overall process, leading to the development of an efficient, economical, and environmentally friendly technology for the conversion of agave residue into bioproducts of industrial interest. Furthermore, this process is positive as it employs a low acid concentration (1.5%) and a short reaction time (30 minutes), when compared to other types of residual biomass. This makes possible to use it as a resource for obtain ethanol and other products by fermentation in the Brazilian semiarid region.

4. CONCLUSION

The bagasse of sisal in natura presented high content of cellulose and hemicellulose. The results show the potential of sisal residue biomass to produce biofuels (bioethanol) in the Brazilian semiarid region using a reduced number of operations. Studies are still needed to obtain the best extraction of the reducing sugars produced and its consequent efficient fermentation to obtain bioethanol.

5. REFERENCES

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