COMPARISON OF DILUTE ACID AND ALKALI PRETREATMENTS OF WHEAT STRAW FOR EFFICIENT ENZYMATIC HYDROLYSIS

Ana Priscila de Alba, *****Oscar A. Rojas-Rejón, Arturo Sánchez,
CINVESTAV – Unidad Guadalajara de Ingeniería Avanzada. Av. del Bosque 1145, Col. El Bajío, Zapopan, Jalisco, México. Tel: (33)3777-3600 Ext. 1102. *Correo-e: oscarr@gdl.cinvestav.mx.

Key words: biofuels, alkaline pretreatment, wheat straw, enzymatic saccarification

Introduction. Wheat straw is an agricultural residue with high content of polysaccharides, and for this reason is attractive as substrate for the production of 2G biofuels and high added-value bioproducts [1-2]. Lignocellulose requires effective pretreatments in order to release sugars from its lignin seal. Thermochemical pretreatments such a dilute acid and alkali provide pretreated solids with selective removal of hemicellulose and lignin, respectively. Compositional changes in pretreated solids impacts over total yields and enzymatic effectiveness. The aim of this work was to compare dilute acid and alkali pretreatments over pretreatment and saccharification yields as well as enzymatic effectiveness.

Methods. Wheat straw was used as raw material. Dilute acid pretreatment (DAP) was carried out according to Rojas-Rejón *et al* (2012) [3]. Alkaline pretreatment (AKP) was carried out with NaOH (0.25–3 % $w \cdot v^{-1}$) at temperature (25 –121°C) and time (5-60 min). Initial solid load was 7.83% ($w \cdot v^{-1}$; dry basis, DB). Enzyme hydrolysis was performed with Accellerase 1500 (17 $FPU \cdot g^{-1}$pretreated straw), incubated at 50°C and 200rpm for 48 h. Liquid samples were analyzed with an YSI 2700 biochemical analyzer in order to determine glucose and xylose.

Results. DAP hydrolyzed hemicellulose fraction and yielded 98 % ($g \cdot g^{-1}$) of xylose as shown in Table 1. Pretreated solids were conditioned and hydrolyzed with Accellerase 1500, glucose yield obtained was 30 % ($g \cdot g^{-1}$). Response surface methodology **(**RSM) was used to analyze dilute alkaline experiments. Monosaccharides were barely detected in alkaline hydrolysates and after enzymatic hydrolysis of conditioned pretreated solids it could be observed that alkali concentration was the most significant factor for glucose and xylose production. After enzymatic hydrolysis of pretreated solids, the highest yields of glucose and xylose obtained at 2.3 % NaOH ($w \cdot v^{-1}$), 46.3 min and 49°C were 68.7 and 74.9% ($g \cdot g^{-1}$), respectively. Improvements for alkali over dilute pretreatments were obtained since $Y_{g/c}$ (glucose yield) increased 2.3 times compared to DAP. Enzymatic effectiveness (EE; mg $cellulose \cdot FPU^{-1}$) was 35.5 and 24.3 for DAP and AKP, respectively.

Pretreated straw had different composition between DAP and AKP since dilute acid pretreatment completely hydrolyzes hemicellulose fraction while alkali detaches and partially hydrolyzes lignin. Despite low xylanase activity registered in Accellerase 1500 (ca. 8 $XYU \cdot ml^{-1}$) at least 74.9% of hemicellulose was hydrolyzed to xylose. Higher content of polysaccharide was present in AKP pretreated solids decreasing specific yield of EE despite higher values of $Y_{M/P}$.

Table. 1 Yields comparisons for DAP and AKP.

	Pretreatement		Saccarification		Total	EE
	$Y_{g/c}$	$Y_{x/h}$	$Y_{g/c}$	$Y_{x/h}$	$Y_{M/P}$	Y_{EE}
DAP	0	98	30	0	57.3	35.5
AKP[1]	0	0	68.7	74.9	64.6	24.3

Y – sugar yield, Y_{EE} – Specific enzymatic effectiveness yield, g – glucose, c- cellulose, x – xylose, h – hemicellulose, M – monosaccharide, P – polysaccharide.

Conclusions. AKP improved saccharification and total yields but not enzymatic effectiveness. DAP obtained the highest xylose yield after pretreatment. Alkali concentration and temperature had the strongest effect in glucose yields after enzymatic hydrolysis.

Acknowledgements. Partial financial support from Secretary of Energy (SENER), México (project SENER – 2009-150001) is acknowledged.

References.

1. McIntosh, S., & Vancov, T. (2011). *Biomass and Energy*, 35;3094-3103.
2. Ragauskas AJ, W. C. (2006). *The path forward for biofuels and biomaterials*; 311(5760):484-9.
3. Rojas-Rejón, O., Cámara, H., & Sánchez, A. (2012). 1CIAB.