ENVR 290: Comparative study of methods for the synthesis of silica nanoparticles from sugarcane waste ash

Abstract: Adding value to agro-industrial solid waste is a challenge for sustainable and green chemistry. Brazil is the worlds largest producer of sugarcane, producing about 633 million tons per year, and generates huge amounts of sugarcane waste ash (SWA) which is a rich source of silica. Therefore, the development of a process related to the use of this raw material rich in Si for the production of silica nanoparticles (SiNPs) is fundamental. SiNPs are presently applied in paints, biopolymers, catalysts, adsorbents, among others [1]. In this study, SiNPs were produced from SWA by different routes and yield and purity of products obtained were evaluated. The synthesis of SiNPs was carried out by the two-step method. First, NaOH was mixed with SWA, and the resultant mixture was fused at 350 C for 30 min or 1 h, varying the ash:NaOH ratio (1:1.5 or 1:2). After, was added distilled water in the funded solid and refluxed for 1 h to leave all the sodium silicate dissolved in the aqueous medium [2]. Then, HCl or H_2SO_4 6.0 mol L^{-1} was added, dropwise, until pH decrease to 2.0. The yield of SiNPs extraction was around 67 % for samples obtained with ash:NaOH ratio 1:1.5, 30 min or 1 h of muffle and HCl solution. So, fusion time was not significant for the yield of the synthesis. Subsequent experiments were conducted at 30 min, ash:NaOH (1:2) and HCl or H_2SO_4 (Table 1). The yield of silica nanoparticles extraction was 93 % and 67 % with HCl and H_2SO_4, respectively. The silica obtained with H_2SO_4 showed lower yield, but higher purity, when compared to the silica obtained with HCl. The yield of silica extraction was higher with ash:NaOH ratio 1:2 and with the HCl. However, the highest purity was obtained with H_2SO_4.

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	Ash	SiO_2 (HCl)	SiO_2 (H_2SO_4)
SiO_2 (wt. %)	68.881	95.869	97.831
Fe_2O_3 (wt. %)	13.801	1.693	-
CaO (wt. %)	8.092	-	-
K_2O (wt. %)	5.835	-	-
TiO_2 (wt. %)	2.483	0.295	0.169
BaO (wt. %)	0.572	-	-
MnO (wt. %)	0.197	-	-
ZnO (wt. %)	0.096	-	-
SrO (wt. %)	0.044	-	-
SO_3 (wt. %)	-	2.083	1.953
CuO (wt. %)	-	0.060	0.047
Yield (%)	-	93.28	66.99

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