# Synthesis and Characterization of Carbonaceous Solid Acid Catalyst from Bamboo for Hydrolysis of Lignocellulosic Sugarcane Bagasse to Produce Reduced Sugar in Ethiopia

**Biruk Abate**
Bahir Dar University, Ethiopia

## Abstract

As the main component of lignocelluloses, cellulose is a biopolymer consisting of many glucose units connected through β-1, 4-glycosidic bonds. Breakage of the β-1, 4-glycosidic bonds by acids leads to the hydrolysis of cellulose polymers, resulting in the sugar molecule glucose or oligosaccharides. Mineral acids, such as HCl and $H_2SO4$, have been used in the hydrolysis of cellulose. However, they suffer from problems of product separation, reactor corrosion, poor catalyst recyclability and the need for treatment of waste effluent. The use of heterogeneous solid acids can solve some of these problems through the ease of product separation and good catalyst recyclability. This study deals with recent advances in the hydrolysis of cellulose by sulfonated carbonaceous based solid acids. The acid strength, acid site density, adsorption of the substance and micro pores of the solid material are all key factors for effective hydrolysis processes. Methods used to promote reaction efficiency such as the pretreatment of cellulose to reduce its crystallinity and the use of ionic liquids or microwave irradiation to improve the reaction rate are also discussed.

The study aimed to evaluate sugarcane bagasse as roughage in lactating cow on feed intake, digestibility, ingestive behavior, milk production and composition, and microbial protein synthesis. Ten Girolando cows at initial body weight of 450Â±25.6 kg and at 143.7Â±30.7 days in milk were assigned in two 5Ã—5 Latin square designs. Five 21-day experimental periods were adopted (1Â° to 14-day: diets adaptation period; 15Â° to 21-day: data collection and sampling period). The diets consisted of four different levels of sugarcane bagasse (45%, 50%, 55%, and 60%) and a control diet, commonly adopted in the region, based on spineless cactus (25% sugarcane bagasse), formulated to meet 12 kg/d milk yield. The dry matter (DM), organic matter (OM), and total digestible nutrients intakes and DM and OM digestibilities observed for 45% and 50% bagasse inclusion were similar to control diet, while that 55% and 60% bagasse inclusion were lower. Cows fed control diet, and bagasse diets of 45%, and 50% levels had the nutritional requirements attended, that guaranteed 12 kg/d of milk yield. The crude protein intake and digestibility of cows fed 45%, 50%, and 55% of bagasse inclusion were similar to control diet. The neutral detergent fiber (NDF) intake and digestibility differ for all bagasse diets related to control diet, while the non-fiber carbohydrates intake and digestibility for cows fed 45% of bagasse were similar for control diet. The intakes and digestibilities of nutrients decreased linearly in function of bagasse inclusion; NDF and indigestible NDF intakes did not vary. The ruminating time, feeding and rumination efficiency, microbial protein synthesis and milk yield decreased linearly with sugarcane bagasse inclusion.

Sugarcane bagasse decreases milk production; however, its inclusion level in between 45% to 50% associated to concentrate could replace diets based on spineless cactus for crossbred dairy cow's producing 12 kg/d of milk.

The objective of this study was to evaluate the efficacy of alkaline-treated sugarcane bagasse fiber on physicochemical and textural properties of meat emulsion with different fat levels. Crude sugarcane bagasse fiber (CSF) was treated with calcium hydroxide (Ca(OH2)) to obtain alkaline-treated sugarcane bagasse fiber (ASF). The two types of sugarcane bagasse fiber (CSF and ASF) were incorporated at 2% levels in pork meat emulsions prepared with 5%, 10% and 20% fat levels. Alkaline-treatment markedly increased acid detergent fiber content (p=0.002), but significantly decreased protein, fat, ash and other carbohydrate contents. ASF exhibited significantly higher water-binding capacity, but lower oil-binding and emulsifying capacities than CSF. Meat emulsions formulated with 10% fat and 2% sugarcane bagasse fiber had equivalent cooking loss and textural properties to control meat emulsion (20% fat without sugarcane bagasse fiber). The two types of sugarcane bagasse fiber had similar impacts on proximate composition, cooking yield and texture of meat emulsion at the same fat level, respectively (p>0.05).

Our results confirm that sugarcane bagasse fiber could be a functional food ingredient for improving physicochemical and textural properties of meat emulsion, at 2% addition level. Further, the altered functional properties of alkaline-treated sugarcane bagasse fiber had no impacts on physicochemical and textural properties of meat emulsions, regardless of fat level at 5%, 10% and 20%.

Cellulosic ethanol is a renewable source of energy. Lignocellulosic biomass is a complex material composed mainly of cellulose, hemicellulose, and lignin. Biomass pretreatment is a required step to make sugar polymers liable to hydrolysis. Mineral acids are commonly used for biomass pretreatment. Using acid catalysts that can be recovered and reused could make the process economically more attractive. The overall goal of this dissertation is the development of a recyclable nanocatalyst for the hydrolysis of biomass sugars. Cobalt iron oxide nanoparticles (CoFe2O4) were synthesized to provide a magnetic core that could be separated from reaction using a magnetic field and modified to carry acid functional groups. X-ray diffraction (XRD) confirmed the crystal structure was that of cobalt spinel ferrite.

CoFe2O4 were covered with silica which served as linker for the acid functions. Silica-coated nanoparticles were functionalized with three different acid functions: perfluoropropyl-sulfonic acid, carboxylic acid, and propyl-sulfonic acid. Transmission electron microscope (TEM) images were analyzed to obtain particle size distributions of the nanoparticles. Total carbon, nitrogen, and sulfur were quantified using an elemental analyzer. Fourier transform infra-red spectra confirmed the presence of sulfonic and carboxylic acid functions and ion-exchange titrations accounted for the total amount of catalytic acid sites per nanoparticle mass. These nanoparticles were evaluated for their performance to hydrolyze the beta-1,4 glycosidic bond of the cellobiose molecule. Propyl-sulfonic (PS) and perfluoropropyl-sulfonic(PFS) acid functionalized nanoparticles catalyzed the hydrolysis of cellobiose significantly better than the control. PS and PFS were also evaluated for their capacity to solubilize wheat straw hemicelluloses and performed better than the control.