OPTIMIZATION OF ACID HYDROLYSIS PROCESS TO OBTAIN BANANA PSEUDOSTEM NANOCELLULOSE

N. F.Vasconcelos[1], J. A. Pinheiro[2], A. I. S. Brígida[3(*)], M. S. M. Souza Filho[4], M. F. Rosa[5]
[1, 2, 4, 5]Embrapa Tropical Agroindustry, Fortaleza, Brazil
[3]Embrapa Food Technology, Rio de Janeiro, Brazil
[(*)]*Email:* ana.iraidy@embrapa.br

ABSTRACT

This work aimed at the optimization of acid hydrolysis processing of nanocellulose using response surface methodology. The effects of sulphuric acid concentration, reaction time and liquid:solid ratio on the hydrolysis of banana pseudostem fiber from the Prata Anã cultivar were evaluated using particle size distribution and zeta potential as response variables. Optimal hydrolysis condition with high nanocellulose yield was obtained with sulphuric acid concentration at 62% (w/w) and liquid:solid ratio of 12.5:1 after 70 minutes of reaction.

INTRODUCTION

Brazil is one of the greatest world producers of banana. This culture has a very short life cycle, and produces a large amount of waste. For 1 ton of banana that are produced, approximately, 4 tons of waste are generated, where the pseudostem is the most significant one, representing 75% of the total waste produced in this culture (Fernandes, 2011). Pseudostem is a lignocellulosic material and its reuse has been directing several researches as biogas production, paper and reinforcing polymers.

A recent study is the use of pseudostem on cellulose nanocrystals production. This material has unique properties, which shows that it can be investigated for applications in high strength packaging materials, high strength substrates for printed electronics, barrier applications, multifunctional composites/coatings and structural materials (Moon, 2012). The cellulose nanocrystals are extracted from cellulose mainly by acid hydrolysis. Some acids can be used as ortho-phosphoric, chloridric and sulphuric, being the last one the most used. The more important hydrolysis process variables to be controlled are temperature, liquid:solid ratio, agitation, acid concentration and time of reaction. These can vary with different sources and/or pretreatment used on lignocellulosic material, which makes necessary optimization studies of the hydrolysis process variables for each system.

RESULTS AND CONCLUSIONS

The chemical characterization of banana pseudostem fiber from the Prata Anã cultivar presented a good cellulose content (48.5%, w/w) and the amount of lignin and hemicellulose was 22.7% and 16%, respectively. Due to this quantity of lignin and hemicellulose, previously to acid hydrolysis for nanocellulose extraction, the fiber was subjected to a chemical treatment with hydrogen peroxide P.A. (30%, v/v) and NaOH 10% (w/w) in order to remove lignin and hemicellulose.

A 2^3 full factorial design was employed to optimization of hydrolysis conditions. The effects of sulphuric acid concentration (40 to 84 %, w/w), reaction time (20 to 120 min) and ratio

liquid:solid (5 to 17) on the hydrolysis of banana pseudostem fiber were evaluated using particle size distribution and zeta potential as response variables. The study occurred in reactional systems with controlled temperature (45°C) and agitation (250 rpm).

The optimized hydrolysis condition, with better nanocellulose yield, was obtained using sulphuric acid at 62% (w/w) and liquid:solid ratio of 12.5:1 after 70 min of reaction. In this condition, the percentage of nanoparticles in the hydrolysate was 60.0 ± 6.7% and zeta potential was -24.5 ± 5 eV. The zeta potential did not show significant variation in this studied conditions, which means this is not acid concentration, liquid:solid ratio and time of reaction dependent.

Fig. 1 show the particles distribution for the optimized hydrolysis condition. It was observed largest amount of particles in a special ranger (< 120 nm) representing the high efficiency of hydrolysis under studied conditions.

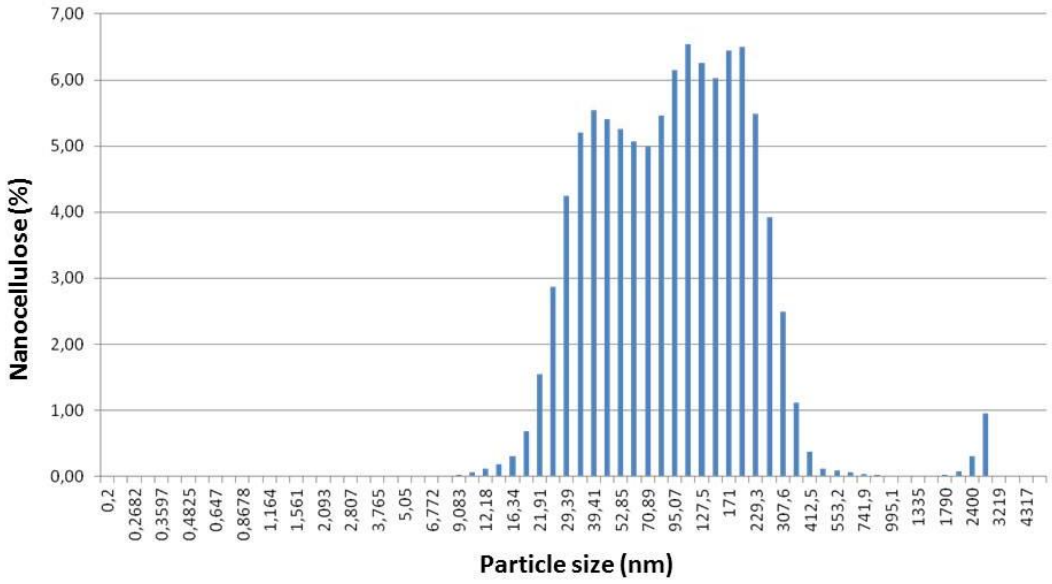

Fig.1 Graph of particle distribution obtained after acid hydrolysis conducted under optimal conditions of operation.

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REFERENCES

Fernandes ERK, Afuso RKS, Schmitt CC, Sellin N, Souza O, Medeiros SHW. Avaliação do potencial para reaproveitamento de resíduos da bananicultura por pirólise. In: II Simpósio Internacional sobre Gerenciamento de Resíduos Agropecuários e Agroindustriais. 2011, Foz do Iguaçu. Anais: Foz do Iguaçu.1 CD-ROM.

Moon R, Walker C. Research into cellulose nanomaterials spans the globe. Paper360°, 2012, p. 32-34.