International Conference on Food
and Agriculture Applications
of Nanotechnologies

NanoAgri 2010

Inventory of resources and emissions of cellulose nanostructures from unripe coconut husks: extraction process

A.C.C. Silva(1), A.C. Cavalcante(1), D.M. Nascimento (2), M.C.B. Figueirêdo(3)*, C.M.L. Ugaya(4), M.F. Rosa(3) and M.M. Souza Filho(3)

(1) Instituto Federal de Educação, Ciência e Tecnologia (2) Universidade Federal do Ceará (3) Embrapa Agroindústria Tropical (4) Universidade Tecnológica Federal do Paraná
* Corresponding author: clea@cnpat.embrapa.br.

Abstract –Inventory of resources and emissions of nanoproducts has been demanded by environmental institutions worldwide to enable life cycle assessment of these products. This work aims to present the preliminary results for the inventory of cellulose nanostructures obtained from coconut husks, considering the extraction process.

Life Cycle Inventory (LCI) of resources and emissions of nanoproducts has been demanded by environmental institutions worldwide to enable life cycle impact assessment of these products. Inventories present measurements of resources (e.g.: kg of materials) and emissions to air, water and soil (e.g.: kg of methane), generated from the raw material extraction to the final disposal stage. The inventoried data is relative to a specific amount of product produced and may be linked to specific environmental impact categories in life cycle impact assessment studies. According to the ISO 14040 [1], inventory studies must define its objective, functional unit and elementary processes considered.

This inventory is part of the life cycle assessment (LCA) study of cellulose nanostructures from unripe coconut fiber that includes three life cycle stages: unripe coconut husks collection and transport, fiber extraction, and nanostructure extraction. The data presented in this work is related only to resources and emissions occurring in the stage of nanostructure extraction (gate to gate LCI). The function of cellulose nanostructures is defined as improvement of mechanical properties of composites and the function unit adopted is the production of 1g of cellulose nanostructures from unripe coconut husks fiber.

The elementary processes involved in the extraction of cellulose nanostructures are milling of coconut husk fibers, washing to remove impurities and waxy substances, bleaching to start removing lignin, acid hydrolysis to obtain nanostructures, centrifugation to separate nanostructures from the acid solution and dialysis to correct the pH of the solution containing nanostructures. The detailed description of this process is presented by Rosa et al [2]. The measurements of resources and emissions were carried out when this process was performed five times in the laboratories of Embrapa Tropical Industry.

The preliminary results of the inventory are presented in Table 1. The studied process presents an efficiency of 6% related to the conversion of unripe coconut fiber into cellulose nanostructures. Considering that the cellulose content of unripe coconut fiber is around 38% [2], there is opportunities for improvements in process efficiency.

The next step of this work is the identification of these opportunities, through the analysis of data in each elementary process. A comparative study will also be performed considering resources and consumptions related to the production of cellulose nanostructures obtained from cotton and sugar-cane fibers. This work has been supported by Embrapa´s Nanotechnology Network (Agronano).

Table 1: Resources and emissions for the production of 1g of cellulose nanostructures.

Inputs	Unit	Average value	Standard deviation	Outputs	Unit	Average value	Standard deviation
Unripe coconut fiber	g	15.89	0.67	Emissions to soil			
Water	L	21.60	2.04	Residues of unripe coconut fibers	g	6,66	0,44
Electricity	kWh	3.95	0.48	Emissions to water			
Sodium hydroxide	g	1.72	0.01	Electric Conductivity (EC)	dS/m	39,909	77,742
Acetic acid	g	0.78	0.05	Oxigen Chemical Demand (DQO)	g	5,519	0,648
Sulfuric acid	g	26.33	2.60	Oxigen Biochemical Demand (DBO)	g	2,693	0,310
Sodium chlorite	g	1.54	0.10	Nitrate	g	0,017	0,002
Nitric acid	g	4.25	0.30	Total Kjeldahl Nitrogen (NT)	g	0,008	0,001
				Phenol	g	0,047	0,004
				Total Phosphorous	g	0,0037	0,0003
				pH		4,731	4,276
				Total Suspended Solids (TSS)	g	0,733	0,088
				Electric Conductivity (EC)	dS/m	39,909	77,742
				Oxigen Chemical Demand (DQO)	g	5,519	0,648

References

[1] Associação Brasileira de Normas Técnicas (ABNT). NBR ISO 14040, Rio de Janeiro, ABNT, 2009.

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