ACTIVATED CHAR PRODUCED FROM CHONTADURO SEEDS: A NEW POTENTIAL PRECURSOR

Luis Angel, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
luedang9507@gmail.com
Audrey Villot, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Yves Andres, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Claire Gerente, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Manuel Rodriguez Susa, Universidad de los Andes, Bogota D.C., Colombia
Jaime Plazas-Tuttle, Universidad de los Andes, Bogota D.C., Colombia

Key Words: Activated char, chontaduro, factorial design, optimization, sustainable.

Activated carbon (AC) is a widely material recognized for its adsorbent properties due to its large surface area and high porosity but principally obtained from non-renewable sources such as coal. These adsorbents show low mineral content, high carbon content and high BET surface areas. However, in the current context of the global environmental transition, it is important to look for alternatives precursors to fossil materials to produce activated chars (ACh) with similar properties to AC by pyrolysis and physical activation. Thus, agricultural residuals as biomass waste represent a potential pool of precursors for ACh due to their availability through the world and carbonaceous nature. However, agricultural waste is different from one country to another.
For example, the *chontaduro*, which is a distinctive biomass from Colombian territory, could provide a pertinent residue to produce AC. Chontaduro fruit is typical from Colombian Pacific and Amazon regions, where 43,000 ton/year are produced without a strategy to dispose of its wastes (shell – 17% w.t. and seeds – 4% w.t.). Under this scenario, the production of ACh from these residues is a sustainable alternative to transform these wastes into a product with added value. Chontaduro seeds (CS) have never been explored as precursor to produce ACh, even though their interesting properties. Proximal analysis and lignocellulosic content analysis carried out show positive results to propose CS as precursor of ACh. Results show low moisture (39.5%), a considerable amount of fixed carbon (9.7% dry basis), and high lignin content (>15% dry basis).
The objective of this study is to optimally produce ACh from CS through a one-step physical activation with steam. To determine the set of conditions that optimize the ACh production, a 2^k factorial design was developed to create the experimental matrix. Four factors for which it is desired to evaluate their influence were selected (i.e., holding time, maximum temperature, temperature ramp and steam flow), two levels per factor were evaluated and six response variables (yield, BET surface area, carbon content, micropore volume, mesopore volume and total pore volume) were proposed to evaluate its quality. These variables were chosen considering that the produced ACh will be used as an adsorbent material in water purification processes, and at the same time it will serve as a support matrix for the immobilization of nanoparticles that will be photoactivated through ultraviolet light. An energy balance was also proposed as an indicator of sustainability, which includes the energy consumption of the activation process and the energy that can potentially be extracted from the by-products (oil and syngas).
The experimental design for the ACh production leads to an experiment with $2^4 = 16$ runs, one per possible combination of low and high values of the factors (Table 1). Different results have been found for different combinations. For example, compared to documented values for other biomasses, the set of low values (-) for all parameters shows adequate values of yield (24%), BET surface area (600 ± 23 m^2/g) and total pore volume (0.299 ± 0.015 cm^3/g). In addition, rudimentary micropore and mesopore volumes were obtained, indicating the start of the porosity development. In the other hand, when holding time and maximum temperature are switched to high values (+), BET surface area (1120 ± 32 m^2/g) and total pore volume (0.603 ± 0.022 cm^3/g) was doubled, but yield was almost halved (14%). The analysis of these variations is performed using ANOVA and statistical tools, which help to determine the best conditions for the response variables. Runs with high values for holding time, maximum temperature and steam flow results in better quality ACh from a multiobjective perspective which considers all response variables.

Factor	Unit	Low (-)	High (+)
Holding time	h	0.75	2
Maximum temperature	°C	850	950
Temperature ramp	°C/min	5	10
Steam flow			

Table 1. Physical activation conditions

Given the high availability of CS, the lack of solutions for their sustainable use and the promising composition of these residues, the right conditions are in place to carry out the production of ACh from this material. This transformation becomes an alternative to the disposal of solid waste, which is a problem that is strongly present in developing countries in Latin America. The first results show a promising impression for CS.