**PREPARATION AND EVALUATION OF ACTIVATED CARBONS FROM RICE HUSKS IN UGANDA FOR REMOVAL OF HUMIC ACID FROM WATER**

# **ABSTRACT**

The Government of Uganda and its development partners have made great strides in promoting rice production, to improve household food security and income. However, as rice production increases, the amount of rice husks generated from the milling process also increases. By 2018, the annual total generation of rice husks was expected to reach 136,000 Mt, more than tripling the rice husk generation of 35,560 Mt in 2008. This poses major environmental concerns, since the huge surplus of rice husks without immediate application is usually disposed off by open dumping and burning, causing environmental pollution. However, with the need for water utilities to comply with the stringent drinking water regulations, the huge surplus of rice husks in Uganda paves way for valorizing rice husks into low cost, environmentally friendly activated carbon (AC) for removal of humic acid from drinking water. Despite this possibility, no evidence of successful utilization of rice husks in Uganda for preparation of AC had been reported. Consequently, conditions best suited for the preparation of AC from rice husks in Uganda were not known. Information regarding the performance of the rice husk-derived ACs towards humic acid removal from water was also limited. This study therefore aimed at developing an optimum route for the preparation of AC from rice husks in Uganda for removal of humic acid from water. This involved, i) characterization and alkaline pretreatment of the rice husks varieties in Uganda, ii) optimization of the pyrolysis conditions, iii) optimization of the physical and chemical activation conditions, and iv) determination of the best conditions suited for humic acid removal from water using the prepared ACs.

Upland rice husk varieties were found more suited AC precursors, due to their lower ash content, higher volatile matter and fixed carbon contents. For purposes of sufficiently lowering the ash content of the rice husks to less/or equal to 5% dry basis (db), a NaOH-concentration of 2-4%w/v was found appropriate for use in the NaOH-pretreatment process. Optimum pyrolysis conditions were found to be temperature (406 oC), heating rate (10 oCmin-1), and heating period (60 min), resulting in char yield, fixed carbon and ash contents of 35.3, 55.4, and 35.0%db, respectively. Based on the product value of carbon yield, *C*, and the total specific surface area, *as,BET,* the best physically activated carbon resulted from char activation at a temperature of 800 oC, for 10 min. At these conditions, the *C, as,BET,* and the *C×as,BET* values were obtained as 53.2%, 756.8 and402.7 m2g-1, respectively. The best chemically activated carbon (AC 400) resulted from rice husk activation at a H3PO4 concentration of 30wt%, and at a temperature of 400 oC. At these conditions, the *C,* *as,BET,*, and the *C×as,BET* values were obtained as 46.9%, 2258.4 and 1058.7 m2g-1, respectively. Despite the higher *as,BET* value, its maximum adsorption capacity (5.3 mgg-1) was lower than 8.9 and 27.2 mgg-1 exhibited by the ACs prepared at a H3PO4 concentration of 30 wt% and at activation temperatures of 500 (AC 500) and 600 oC (AC 600), respectively. Therefore, other factors rather than surface area alone had significant influence over humic acid removal. The best conditions for humic acid removal included; adsorbent dose (0.5 g), contact time (70 min), and solution pH (2). The adsorption capacity of AC 600 was comparable to that of the commercial AC. Overall, the study revealed that the rice husks in Uganda have good prospects for utilization in AC production for humic acid removal from water.

***Keywords:*** Humic acid, drinking water, rice husk, physical activation, chemical activation