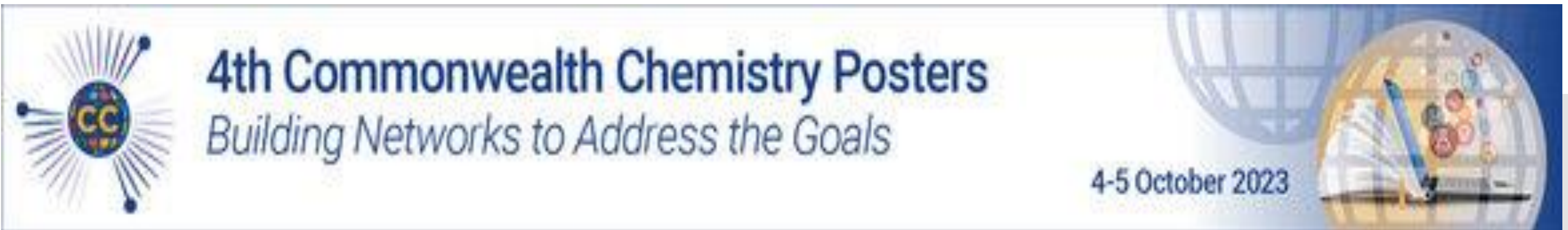




PHYSICOCHEMICAL AND ENERGETIC PROPERTIES OF CHARCOALS PRODUCED FROM RESIDUES OF TWO TROPICAL WOODS FROM CAMEROON

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1. ABSTRACT

The aim of this study was to determine the physicochemical and hygroscopic properties of charcoals from Doussie (*Azelia africana*) and Okan (*Cylicodiscuis gabunensis*), produced from residues of two tropical woods from Cameroon. The properties determined for these charcoals included physical (moisture content, basic density, high heating value) chemical (proximate analysis, ultimate analysis, FT-IR analysis) and hygroscopic (absorption, sorption) properties. Our results show that these properties differ between the two woods. Higher values were obtained with Okan, except for the fixed carbon content. A higher diffusion coefficient on water uptake was also observed with charcoal from Okan ($3.25 \times 10^{-8} \pm 0.22 \times 10^{-8} \text{ m}^2/\text{s}$) compared to charcoal from Doussie ($2.42 \times 10^{-8} \pm 0.21 \times 10^{-8} \text{ m}^2/\text{s}$). The highest equilibrium moisture contents in sorption are obtained with charcoal from Okan. A relationship between hygroscopic behavior and charcoals properties has been found. In addition, an increase of initial moisture content of charcoals about 19% provokes a decrease in their initial fixed carbon content about 2% and in their initial high heating value about 2.5%. The charcoals studied are of good quality and meet the recommended standards for domestic use even in humid areas. The charcoal from Doussie has shown a lower volatile matter content of ($22.93 \pm 0.51\%$) than that from Okan has value of ($24.19 \pm 0.62\%$). Charcoal from Okan has displayed a lower fixed carbon content ($67.52 \pm 0.57\%$) compared to that from Doussie ($69.87 \pm 1.02\%$).

2. METHODOLOGY

Proximate analysis

- Moisture content (MC); ash content(AS) and volatile matter(VM) were determined using the gravimetric method, respectively, following the experimental protocols described by ASTM D 1762-84 (2001); ASTM D 1102-84 (2007) ; ASTM D 5832-98 (2014)
- The basic density was determined by the hydrostatic method according to the standard ASTM D 712 (2013)
- Fixed carbon was calculated according to the formula: $FC = 100 - (MC + VM + AS)$

- The higher heating value (HHV) was measured according to ASTM D 5865 (ASTM 2012) using an XRY-1A+ brand electronic oxygen calorimeter bomb.

FTIR-ATR Analysis

Humid charcoal was dried at 105°C for 24 hours then ground to powder of 315 µm size. A few milligrams of this powder were deposited on the diamond crystal of the ATR stage. The spectra were recorded by scanning over a spectral region from 4000 to 400 cm⁻¹ with a resolution of 4 cm⁻¹.

Experimental Determination of Sorption Isotherms

The adsorption and desorption isotherms of charcoal obtained from Doussie and Okan were determined at a temperature of 30°C, by the static gravimetric method, which used six saturated salt solutions (KOH, LiCl, K₂CO₃, NaBr, NaCl, and KCl) with water activities ranging from 0.08 to 0.836. A total of 48 charcoal samples of both species of cubic shape(3 × 3 × 3) cm with approximate mass of 0.1 ± 0.01 g were prepared.

Experimental Determination of Diffusion Parameters during Capillary Absorption

Fick's second law was used to determine the diffusion coefficients of water in charcoal

$$\frac{m_t - m_0}{m_{eq} - m_0} = \frac{2}{\sqrt{\pi}} \left(\frac{S}{V} \right) \sqrt{Dt} = \alpha \sqrt{t}$$

3. RESULTS

3.1. Physical,chemical and energetic properties of charcoals studied

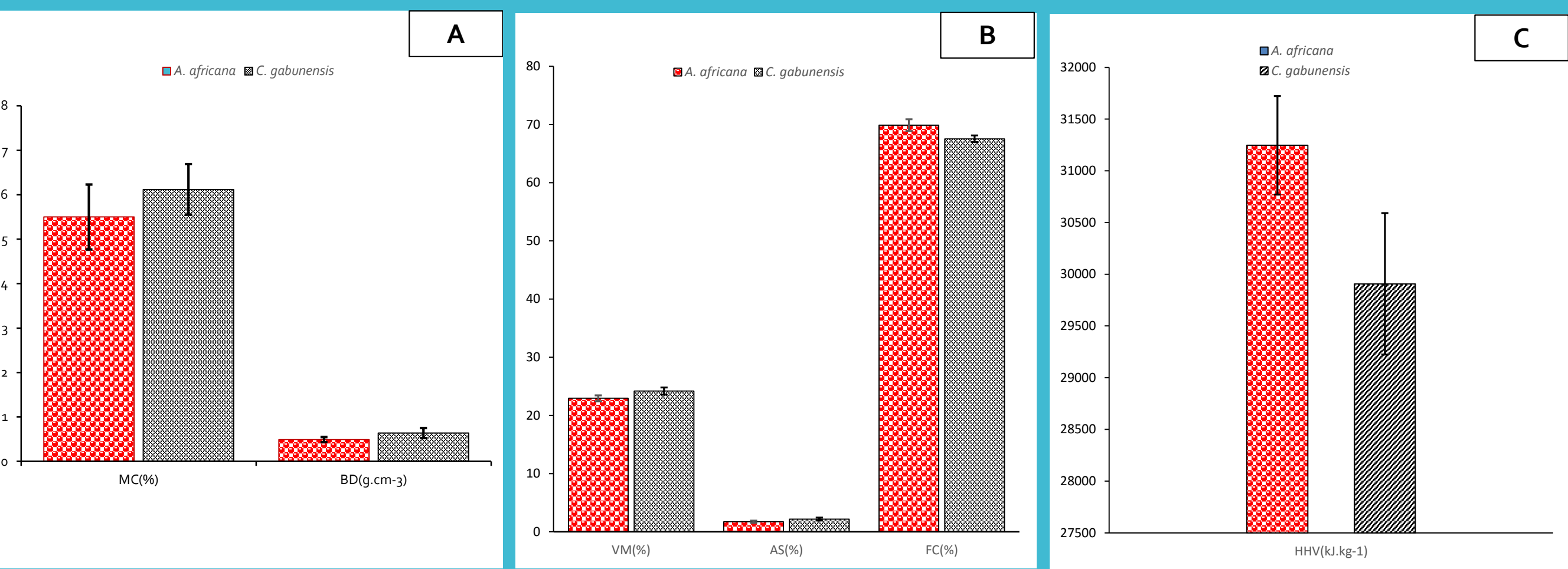


Figure1. (A) Physical properties; (B) Chemical properties; (C) Energetic property

3.2. FTIR Spectra Analysis of charcoals studied

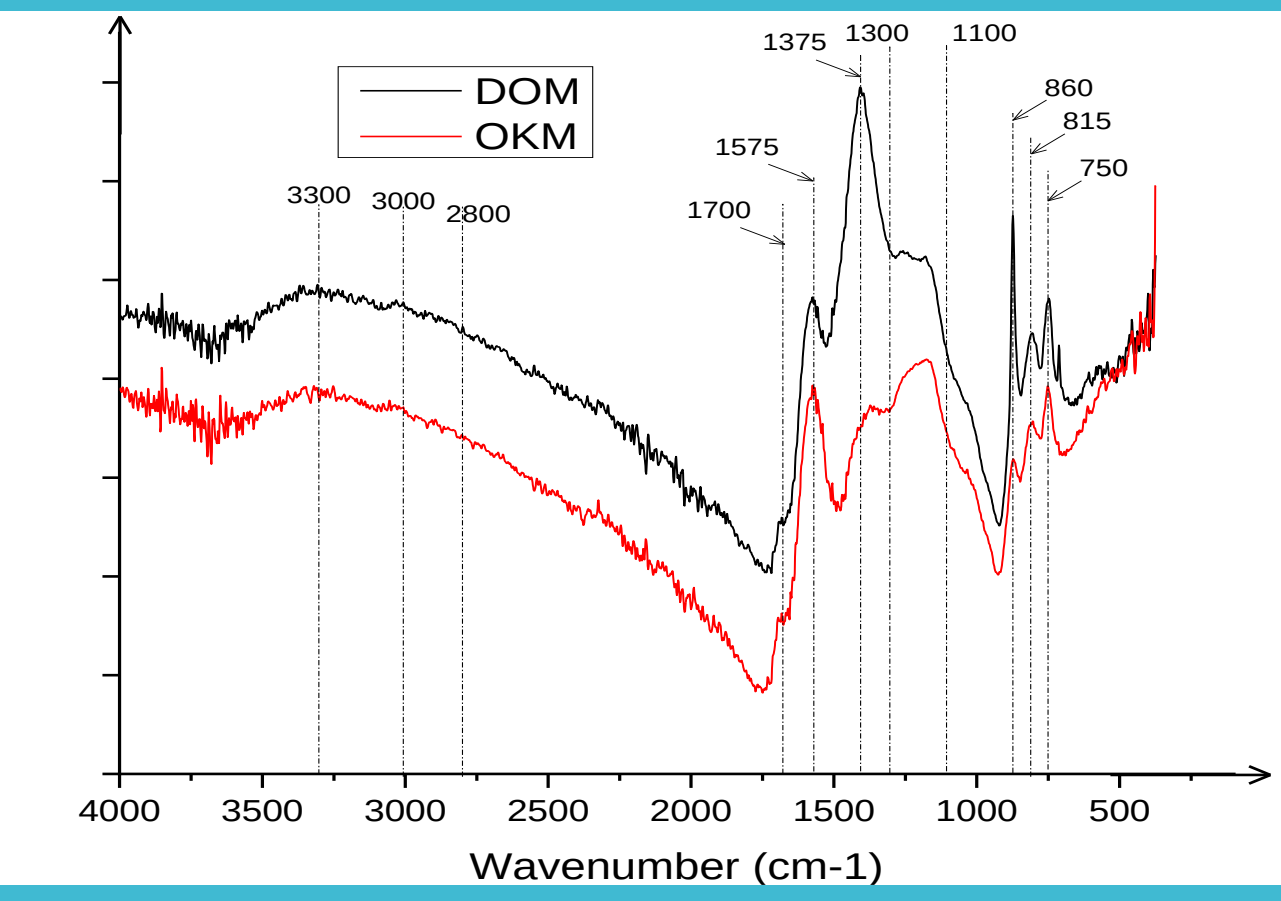


Figure 2. FTIR spectra of charcoals from Okan (OKM) and Doussie (DOM)

3.3. Hygroscopic behavior of charcoals studied

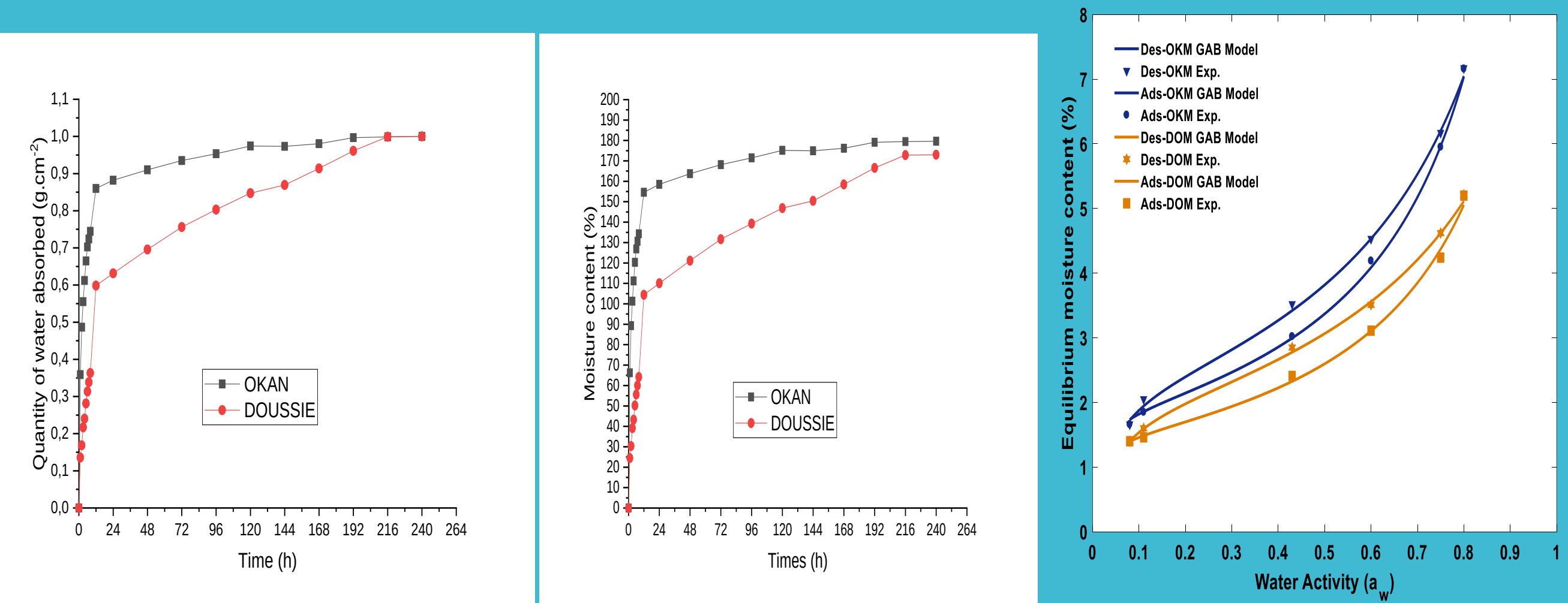


Figure 3.. Variation of the quantity of water absorbed by charcoals

Figure 4. Moisture absorption curve of charcoals in relation to wood species

Figure5. Moisture sorption isotherms of charcoals from Okan(OKM) and Doussie(DOM)

3.4. Correlation between the properties of charcoals studied

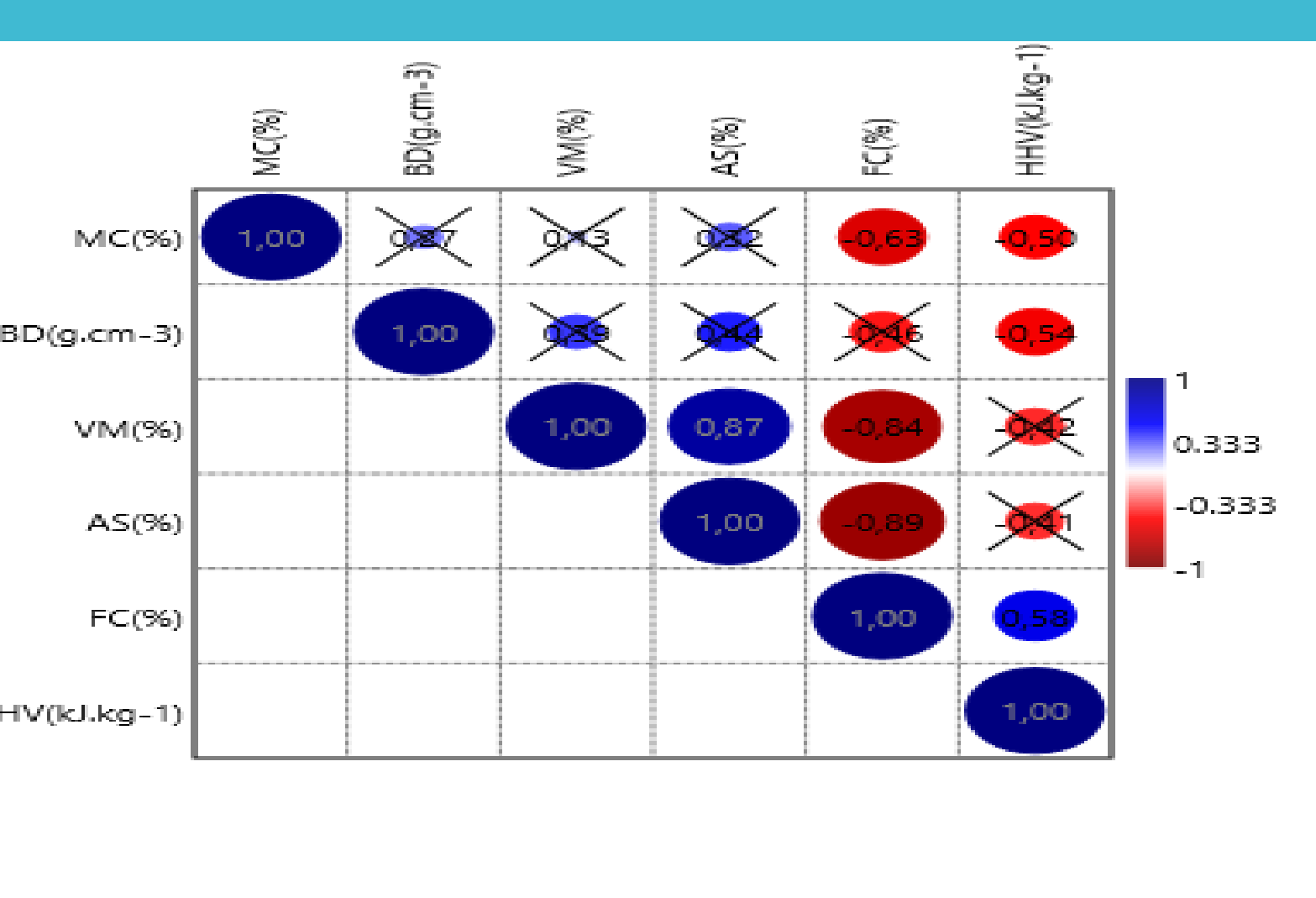


Figure 6. graph of the linear pearson correlation between the properties of charcoals studied

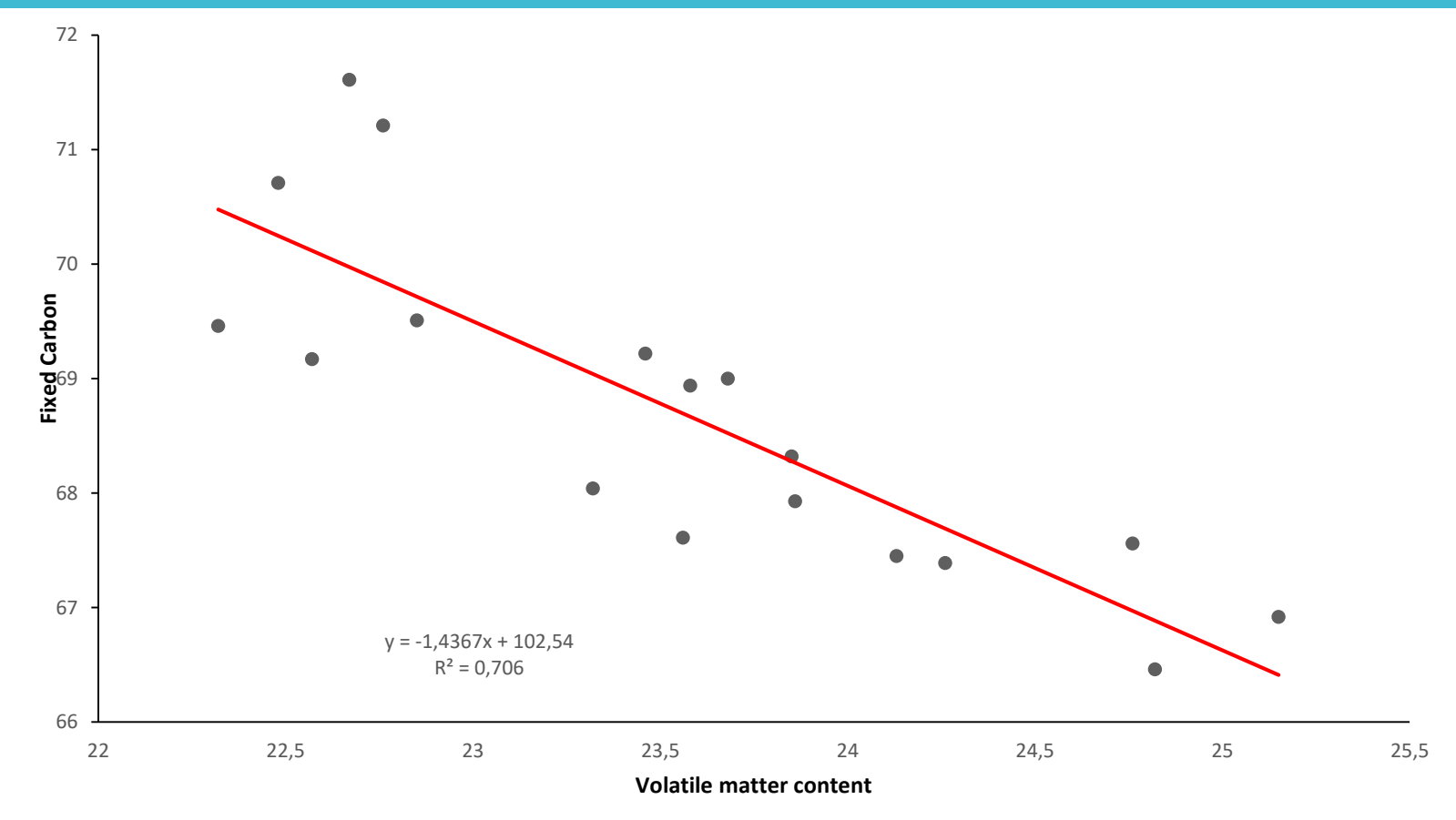


Figure 7. correlation between Fixed Carbon content and Volatile Matter content

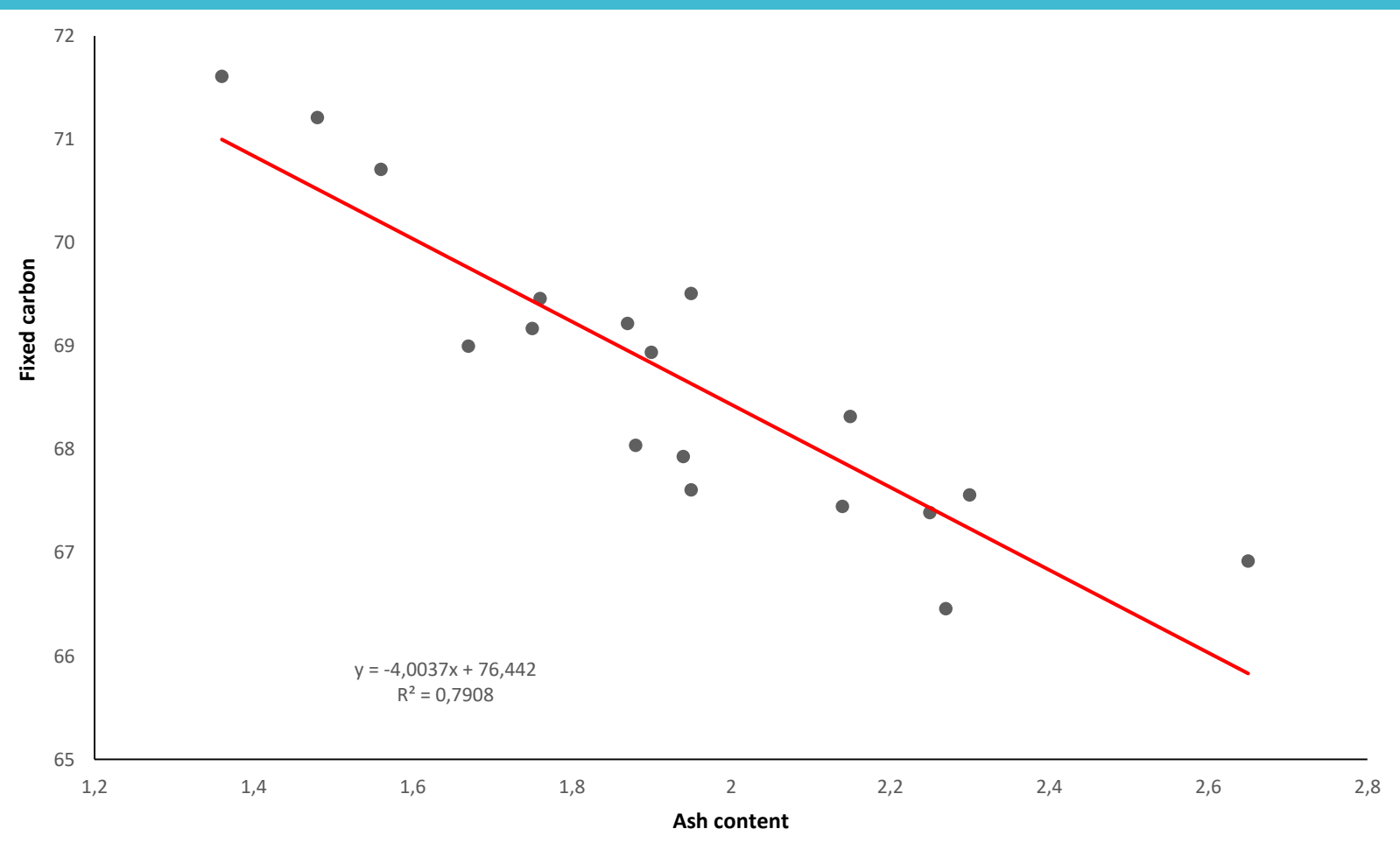


Figure 8. correlation between Fixed Carbon content and Ash content

4. CONCLUSION

The results of this study show that the species of wood is a factor which considerably influences the properties of charcoal, but also that the charcoal from the waste of two tropical woods, *Cylicodiscuis gabunensis* and *Azelia africana* present physical, chemical and interesting energy properties for their use as domestic fuel. However, from a hygroscopic point of view these properties remain influenced by the adsorption and absorption of humidity and therefore must be stored away from humidity to avoid deterioration of their quality.

5. ACKNOWLEDGEMENT

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