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Wood Density Determination with the Perspective to Decarbonisation of Tropical Forest Species from the Luki Biosphere Reserve in the Democratic Republic of the Congo

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Abstract

Specimens of the forest species such as *Pentaclethra macrophylla*, *Petersianthus macrocarpus*, *Pycnanthus angolensis* and *Terminalia superba* have been sampled from LUKI Biosphere reserve in the Democratic Republic of the Congo in order to determine their wood density with the perspective to decarbonisation. These parameters have been found out experimentally utilizing a drying technique in an oven including techniques of immersion in an Erlenmeyer full of water. The corresponding results indicated that the four species wood density is respectively 0.85, 0.80, 0.77 and 0.51. These preliminary results will be useful in our ongoing project on carbon dioxide absorption capacity of Congo rainforest tree species.

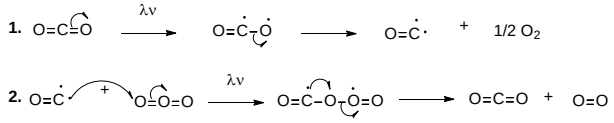
Keywords

Carbon Dioxide, Congo Rainforest, Decarbonisation, Wood Density

1. Introduction

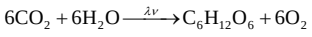
This work is the preliminary study of the ongoing project on carbon dioxide absorption capacity of some Congo rainforest tree species. In this regard, the es-

sential objective is to discover the wood density of *Pentaclethra macrophylla*, *Petersianthus macrocarpus*, *Pycnanthus angolensis* and *Terminalia superba* to select the best species for decarbonisation. It is important to mention that all these species are characteristic of the Congo rainforest, which plays a key role in preventing excessive accumulation of carbon dioxide in the atmosphere. [1] [2] [3] A such accumulation is a root of the degradation of ozone layer (**Scheme 1**). [4] Consequently, this kind of decomposition of the ozone layer essentially leads to global warming and unexpected climate modifications, which disturb the welfare of living organisms. [4]



Scheme 1. Decomposition of the ozone layer in the presence of carbon dioxide.

It is interesting to remember that the potential to transform carbon dioxide to generate corresponding products could be proportional to the wood density of a plant species (**Scheme 2**). [5] In other words, the volume of water in plant tissues could explain the aptitude of plants to convert carbon dioxide, for example, during the photosynthesis process (**Scheme 2**). [5]



Scheme 2. Carbon dioxide degradation in the presence of light.

Wood density of the studied Congolese rainforest trees in the perspective of decarbonisation has not been reported. In this regard, investigations on Congo Basin Forest have been reported in the literature, but they have no connection with the forest species as well as the objectives of this current research. [6] [7] Indeed, wood density has been disclosed in the literature in the context different from that of our research.

2. Experimental Procedures

2.1. Plant Taxonomy

We started this study by identifying and classify the four plant samples (**Table 1**). [8]-[17] We also described each sample before determining the density. [8]-[17]

2.1.1. *Pentaclethra macrophylla*

Pentaclethra macrophylla is a tree of at least 21 m in height with more or less extensive domed crown. [8]-[17] This tree is dense partially sinuous reaching 40 cm in diameter. This species is greyish, red orange when it is cut and it is little thick. It has young twigs puberulent, and leaves with linear stipules. [8]-[17] According to the experimental observations reported in the scientific literature, this species is a useful pharmacological plant. [8]-[17] Nucleophilic organic compounds, such as flavonoids and alkaloids, have been also detected in this plant. [18]

Table 1. Classification of plant samples.

	Pentaclethra macrophylla	*Petersiqnthus macrocarpus*	*Pycnanthus angolensis*	*Terminalia superba*
Kingdom	Plantae	Plantae	Plantae	Plantae
Subkingdom	Angiosperms	Angiosperms	Angiosperms	Tracheobionta
Division	Dicotyledons	Dicotyledons	Dicotyledons	Magnoliophyta
Class	Rosids	Rosids	Rosids	Magnoliopsida
Subclass	Fabids	Asterids	Magnoliids	Rosids
Order	Fabales	Euricales	Magnoliales	Myrtales
Family	Fabaceae	Lecythidaceae	Myristicaceae	Combretaceae
Genus	Pentaclethra	Petersianthus	Pycnanthus	Terminalia
Species	macrophylla Benth	Macrocarpus (p. Beav) Liben	Angolensis (Welw) Warb	Superba (Eugl and Diels)

2.1.2. *Petersianthus macrocarpus*

Petersianthus macrocarpus is a large, leafy deciduous tree reaching 45 m high and 60 cm in diameter. [19] [20] [21] This species has a deeply fissured rhytidome longitudinally as well as very fibrous bark including unpleasant smell, and yellowish white sapwood. It has a reddish wood quite hard and a spherical crown, spiral leaves grouped at the end of branches along with a petiole of about 17 mm long. [19] [20] [21] It has been reported that the stem back of *Petersianthus macrocarpus* is used traditionally as medicine to ease pain, and fever connected with malaria. [19] [20] [21] Phenolic organic compounds have been reported due to the phytochemical analysis of this species. [19] [20] [21]

2.1.3. *Pycnahthus angolensis*

It is monoecious or dioecious flowering plant. Branches are gathered at the top and more or less perpendicular to the trunk. [22] [23] [24] [25] [26] It has hairy twigs and grayish brown bark and few leaves. [22] [23] [24] [25] [26] This species is useful in African medicine as well as in Asian medicine due to its therapeutic properties, and in this perspective this plant should be protected because it could disappear as a consequence of uncomfortable human activities. [22] [23] [24] [25] [26]

2.1.4. *Terminalia superba*

It is a plant of around 30 m in height and 1.10 m in diameter, provided with winged buttresses up to 5 m in height. [22] [23] [24] [25] [26] This plant has a broadly spreading domed crown, young twigs with golden russet hairs. It has leaves with petiole from 3.5 to 5 long possessing a pair of marginal glandes into its upper half, pubescent when young, cuneate at the base, short and obtusely acuminate at apex throughout 9 cm long and wide. [22] [23] [24] [25] [26]

3. Sampling

Samples for the four studied species were collected from the Congo rainforest by a team of environmentalists accompanied by native people. Three samples for

each species have been utilized in this experimental study.

4. Density Determination

Wood density of the studied forest species was calculated by determining the mass and volume of each species. Indeed, samples wrapped in aluminium foil were placed into an oven set at 105 degrees Celsius, and regularly weighed using an analytical balance (brand KERN 440-35N) until a constant weight was obtained (Tables 2-4). Regarding the volume, each species was placed in a container filled with water and the overflowing water was collected into a graduated cylinder to determine the corresponding volume (Table 5). This experiment was repeated three times for each forest species, and the mass to volume ratio gave us the expected wood density (Table 6).

5. Results and Discussion

In the course of our ongoing decarbonisation research, we report herein our preliminary results regarding the determination of wood density four Congolese rainforest species. In this perspective, each plant species was divided into three samples and each sample was heated into an over to remove its quantity of water. During dehydration, we noticed that the samples weights decreased as heating time increased, and the constant weights were reached from the 96th hour (Tables 2-4, Table 7). In this regard, the forest species, which have a significant density, are very good for decarbonisation (Scheme 2).

Table 2. *Terminalia superba*.

Initial weight (g)	Sample 1 **249**	Sample 2 **331**	Sample 3 **354**	Average weight **311**
Time (h)				
24	105	153	164	
48	102	149	161	
72	99	145	159	**133**
96	**99**	**144**	**157**	
120	98	144	157	
144	98	144	157	

Table 3. *Pentaclethra macrophylla*.

Initial weight (g)	Sample 1 **220**	Sample 2 **380**	Sample 3 **405**	Average weight **335**
Time (h)				
24	96	164	179	
48	95	163	175	
72	93	162	174	**142**
96	**92**	**160**	**174**	
120	92	160	174	
144	92	160	174	

Table 4. *Pycnanthus angolensis*.

Initial weight (g)	Sample 1 **252**	Sample 2 **462**	Sample 3 **474**	Average weight **396**
Time (h)				
24	111	216	223	
48	110	213	222	
72	110	213	220	**180**
96	**109**	**212**	**220**	
120	109	212	220	
144	109	212	220	

Table 5. Wood volume.

Forest species	Sample 1	Sample 2	Sample 3	Total (ml)	Average (ml)
T. superba	294	280	213	787	262
P. macrophylla	200	192	105	497	166
P. angolensis	271	267	160	698	234
P. macrocarpus	280	268	150	698	233

Table 6. Wood density.

Forest species	Average weight	Average volume	Density
T. superba	133	262	0.51
P. macrophylla	142	166	0.85
P. angolensis	180	234	0.77
P. macrocarpus	186	233	0.80

Table 7. *Petersianthus macrocarpus*.

Initial weight (g)	Sample 1 **207**	Sample 2 **437**	Sample 3 **445**	Average weight **363**
Time (h)				
24	97	233	245	
48	94	229	243	
72	92	228	241	**186**
96	**92**	**227**	**240**	
120	92	227	240	
144	92	227	240	

6. Conclusion

We have obtained encouraging preliminary results to pursue our project upon decarbonisation. This project aims to constitute a Congo rainforest plant best species library capable of absorbing a sufficient amount of carbon dioxide. These categories of plants will be adequately preserved and when deforestation occurs,

a proper reforestation programme is essential in order to maintain the Congolese rainforest green because this particular forest is fundamental to minimise the carbon dioxide repercussions upon the ozone layer (Scheme 1).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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