Tropentag 2014, Prague, Czech Republic
September 17-19, 2014

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the Czech University of Life Sciences Prague

Acacia seyal var. *seyal*: A Multipurpose Tree Species for Rural Development, Hunger and Poverty Alleviation in Sudan

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Introduction

Acacia seyal var. *seyal* is considered as one of the most widely distributed tree species in Sudan particularly in the poor rural area; nevertheless rural populations are not benefiting much from its wood. *Acacia seyal*'s uses concentrate in charcoal, firewood and fuel wood due to the lack of information on its wood properties. Despite the richness of Sudan in most of basic factors required to establish forest based industries it still depend almost entirely on imports to satisfy its needs of the products of such industries like pulp and paper, fibreboard,. . .etc. There is an urgent need to evaluate the available locally raw materials as potential sources for forest bases industries. This would not only reduce imports, but it would also promote rural development alleviate poverty and improve livelihoods of local communities. The present study was carried out to investigate the wood properties of *Acacia seyal* var. *seyal* and assess its suitability for pulp and paper and flooring industries. The wood materials were collected from different zones in Sudan. Some anatomical, mechanical and physical properties were investigated.

Material and Methods

Material:

The wood raw materials were obtained from thirty trees collected randomly from 10 forests located in four states in Sudan namely: North Kordofan State, South Kordofan State, Blue Nile State and White Nile State. According to the mean annual rainfall for ten years (2000 - 2009), the study areas were divided into two zones; zone one: with a relatively low rainfall (273mm annually, mean average rainfall), and zone two: with relatively high rainfall (the mean average rainfall is 701 mm annually).

The location and characterization of the study areas are illustrated in Figure 1, while sampling procedure is presented in Figure 2.

Three healthy and straight trees were selected randomly and cut down from each forest give a total of 30 trees. The tree total height, merchantable height and diameter at breast height (DBH) were measured for each tree.

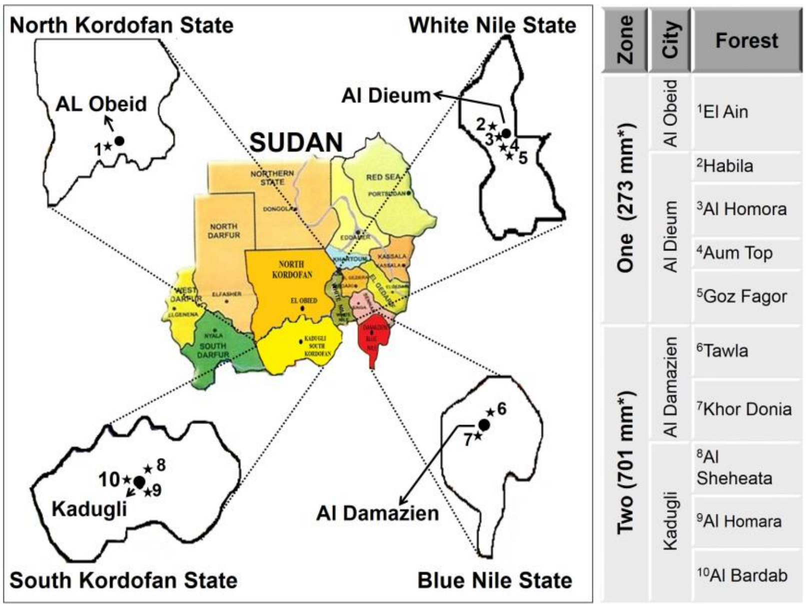

Figure 1: Location and characterization of the study areas (*= Zone's mean annual rainfall of 10 years starting from 2000 until 2009)

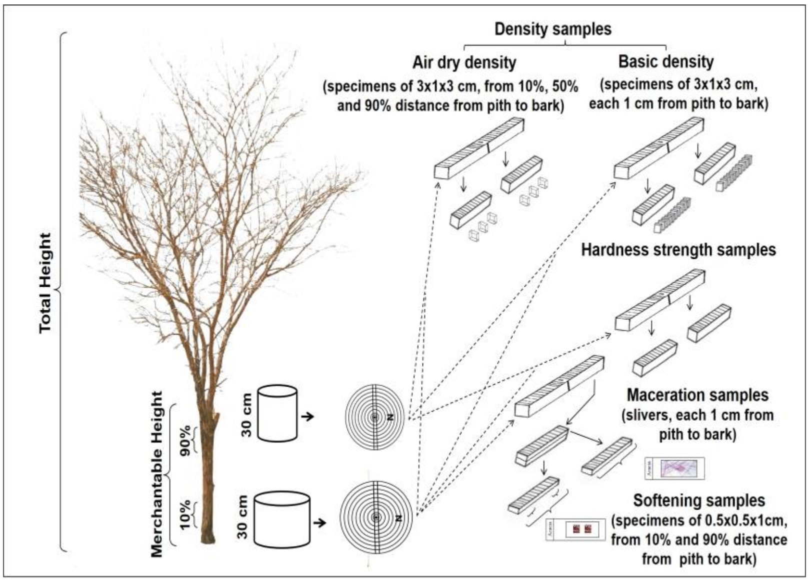

Figure 2: Tree sampling

Two discs of 30 cm thick were obtained from each tree at 10 % and 90 % of the merchantable height. Afterwards the discs were cut into small samples or strips (include tree's pith) with 3 x 3 x tree diameter in cm. Then each strip was cut into small samples and used for wood properties investigations (for more details see Figure 2).

Methods:

Wood density

Two wood density types were measured in the current study: basic density as well as air dry density. The wood density of the tree species was determined using the dry weight and green volume. The specimen's green volume was determined using the water displacement method. The specimens were then immediately transferred into an oven and dried for 48–72 hours until the constant mass was attained. After oven drying, the specimens were weighted using sensitive balance. This weight was taken as the oven-dried weight.

The wood air dry density was measured as air dry mass/air dry volume.The air dry gravimetric method was conducted on the basic of DIN 52 182 (Anonymous 1991). The samples were conditioned to a constant mass at 20 °C air temperature and 65 % relative humidity. The specimens' weight was measured using a sensitive digital balance. The volume was measured using micro callipers (Mitutoyo Digimatic, Model CDN-P30).

Fiber dimensions and their derived values

Two anatomical tests were conducted, maceration test (Schultze's maceration method) and the softening test (Softening in autoclave device method). The measure fiber dimensions were: length, diameter and lumen diameter. Fiber wall thickness was calculated as fiber diameter- fiber lumen diameter / 2. Three derived values were calculated using the measured fiber dimensions as follows: Flexibility coefficient as fiber lumen diameter/fiber diameter × 100, Runkel ratio as 2 × fiber cell wall thickness/fiber lumen diameter and Slenderness ratio as fiber length/fiber diameter.

Hardness strength

Brinell hardness test was conducted on the basic of DIN EN 1534 (Anonymous 2000) to measure the hardness strength of the studied species. The TIRA test 28100 machine provided by a hardened steel ball with a diameter of 10 ± 0.01 mm was used to perform the hardness test in the transverse and radial sections.

Results and Discussion

Acacia seyal var. *seyal*'s fibers characteristics, wood density and hardness strength mean values obtained in the current study are within the normal range for hardwoods species. The suitability of the study species for pulp and paper making (PPM) was assessed by comparing the study species wood basic density and fibers characteristics with those of the acceptable values for PPM and with *Gmelina arborea* which is considered as the prime source for PPM (Table1).

Table1: *Acacia seyal* wood basic density and fibers characteristics in comparison with the acceptable values for PPM and *Gmelina arborea*

Property	*Acacia seyal*	Acceptable values for PPM	[6]*Gmelina arborea*
Density (kg/m³)	724.68	350-650[1]	510
Fiber length (mm)	1.26	≥ 1[2]	1.28
Flexibility coefficient (%)	34.44	> 60[3]	73
Runkel ratio	1.99	0.25 - 1.54[4]	0.39
Slenderness ratio	117.76	> 33[5]	50

[1]Casey (1980), [2]Source 1, [3]Petri (1952), Okereke (1962), Rydholm (1965), [4]Valkomer (1969), [5]Xu et al. (2006) and [6]Ogunkunle and Oladele (2008).

According to the study results, *Acacia seyal* has slightly higher density mean value, longer fiber, and higher slenderness ratios than the acceptable values for PPM. It also has comparable fiber length and higher slenderness ratio than *Gmelina arborea*. Therefore, it is considered compatible for pulp and paper making.

The suitability for flooring industry was assessed by comparing the study species wood air dry density and hardness strength with those of *Milletia laurentii* and *Quercus rubra* which commercially used for such industry (Table 2).

Table 2: *Acacia seyal* wood air dry density and hardness strength in comparison with *Milletia laurentii* and *Quercus rubra*

Property	*Acacia seyal*	**Milletia laurentii*	**Quercus rubra*
Density (g/cm³)	0.893	0.860	0.700
End hardness (N/mm²)	84.03	39	60
Side hardness (N/mm²)	51.18	24	33

*WAGENFÜHR (2007)

According to the results, the study species has higher air dry density and hardness strength than *Milletia laurentii* and *Quercus rubra.* This enhance the suitable of the study species for flooring industry.

Conclusions and Outlook

Wood density, fiber dimensions and hardness strength of the studied species are in the normal range for hardwoods. In general wood density and fiber characteristics of the study species are compatible for paper industry. Also their hardness strength as well as density are compatible for flooring industry.

From the results, it is obvious that the studies species can be put to better use than conversion to firewood and charcoal. Their suitability for such advanced industry would not only reduce imports, but also would provide an economic incentive to the forestry and industrial sectors of Sudan.

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