Potentials of Sawmill Wood Wastes for Pulp and Paper Production

Adetogun, A. C.[1], Omole, A.O.[2] and Adejumo, T.O.[1]

[1] Department of Forestry and Wildlife University of Agriculture, Abeokuta
[2] Department of Forest resources Management, University of Ibadan

Abstract

This study was carried out to assess the suitability of sawmill wood wastes as potential raw matterials for the production of pulp and paper in Nigeria. Sawmill wastes of three wood species; Aningeria robusta, Nesogordonia papaverifera and Terminalia ivorensis were selected for the study. There were three test factors; control, shavings and saw dusts. The collected wood samples were macerated using a solution of glacial acetic acid and hydrogen peroxide. Data collected were analysed using a combination of descriptive and anova. The result showed that the average fibre length of the species for the control ranged between 1.1321mm, 1.0660mm and 1.5040mm for Aningeria robusta, Nesogordonia papaverifera and Terminalia ivorensis respectively. The fibre lengths of wood shavings are 1.0978mm, 1.0361mm and 1.2888mm for Aningeria robusta, Nesogordonia papaverifera and Terminalia ivorensis respectively while the fibre lengths of the sawdust are 1.0391mm, 0.8694mm and 1.1495mm respectively. Average fibres lengths of untreated wood of the studied species compare favorably with those of Gmelina arborea and fourteen Nigerian Savanna species Average fibres lengths of untreated wood of the studied species compare favorably with those of Gmelina arborea and fourteen Nigerian Savanna species It was however discovered that the effect of machining of wood on the fibre length is significant. Sawdust and shavings should be explored for paper production in Nigeria. Research should be carried out to establish the pulping characteristics of sawdust and shavings and the paper grades for which they are best suited. Research should also reveal the form the degree of modification like blending with long fibre pulp that should be incorporated into the materials in order to perfect them for the desired use (s)

Key Words: *Wood Waste, Research, Raw material, Fibre length, Pulping*

Introduction

In Nigeria and other parts of the world, the utilization of wood wastes for pulp and paper production can be viewed from economic and ecological point of view. From the economic standpoint, it is imperative that a huge amount of wood waste is produced by wood based industries notably sawmills. The wasted materials can serve as a readily available and cheap fibre source for the pulp and paper industry in Nigeria. Shortage of raw materials is the major constraint facing the industries in recent times in Nigeria; this is because the industry depends on wood pulp. There is therefore every need to develop economic supplies of wood pulp by using the abundant waste generated by sawmills in the country. The rising demand for paper and paper products in the economy calls for the need to develop alternative raw materials or best supplement available supplies. Importation of wood pulp constitutes a drain on the country's foreign exchange which can in this wise be conserved by development of cheap and available fibre source among which are utilization of wood wastes. (Asabe, 1989).

More so, there is competition between the pulp and paper industry and other wood using industries for wood from the natural forest. Pulp wood plantations in the country are inadequate in meeting the pulp wood requirements due to the high cost of establishment and maintenance which worsen the pulp wood situation. The utilization of wood waste for pulp production offers a partial solution to the problem. Utilization of wood wastes for pulp production is not determined by the possibility of processing it alone, other factors such as economic availability offers an objective basis for its utilization. The profitability of processing wood wastes will depend on its prices and availability in commercial quantities. In view of this, utilization or sawmill wood wastes proposed for the study is economically feasible because it is readily available and cheap.

From the ecological point view, the forest is a renewable resource; its renewability depends on the trend of its use. The forest which is the life wire of every wood based industry is fast disappearing as a result of wanton exploitation and wastage in use which has been threatening the continuous availability of the resources. The forest estate can only be saved from further degradation through research and utilization technology which should also be utilized in conserving forest resources. This can be achieved by recycling of woods wastes for conventional and new products; the objective of which is to ensure fuller use of the forest wood resource thus extending the raw material based as has been done for other resource like mineral resource, e.g. recycling of scrap iron and steel.

For many years the hardwoods were not highly regarded as raw materials for pulp, due in large measure to the shortness of their fibres, but hardwood pulp are now becoming increasingly important in the paper industry. Many grades of paper do not require the high strength characteristics for their end-use applications, and to these grades hardwood pulps bring other desirable characteristics. Smoothness, opacity, and evenness of sheet formation are important in the cultural or white papers (printing and writing grades0 and hardwood pulps offer definite advantages in attaining these characteristics. The study is set to examine the suitability of sawmill wood wastes for pulp production in Nigeria. It is deemed justified since the end result is aimed at improving the raw material situation of the pulp and paper industry.

According to FAO (2003) waste in lumber production is high –on the order of 30-50%, depending on the type of machines used, diameter of the logs and the quality of wood. Fibre length is the most important factor that determines paper properties notably strength and paper making potentials.

The objective of this study is to determine the suitability of wood wastes as potentials raw materials for pulp and paper production in Nigeria. In view of this, splinters, shavings and sawdust of *Aningeria robusta, Nesogordonia papaverifera* and *Terminalia ivorensis* from the sawmilling industry .were used.

Materials and Methods

Pure wood samples of shavings and saw dust of the studied species were collected from Bodija timber market, Ibadan. The samples were kept in polythene bags, labeled and stored in the conditioning room until it's required for use.

Pulp Preparation

Test materials for maceration were prepared by cutting thin slices (slivers) from the samples using a blade; this was not done for sawdust which was already in small bits. The test materials were macerated to isolate the fibres. Macerated was done by placing the slivers in a solution of equal volumes of glacial acetic acid and hydrogen peroxide,, the mixture was then placed in an oven for six hours at 105°C (Fig 1). The hydrogen peroxide is to act as bleach while the acetic acid acts as the cooking medium with softening action on the silvers. The slivers were removed from the solution and washed several times with and later shaken in water with glass beads, this separates the fibres.

Random samples of macerated fibres were mounted on slides and examined under a leitz stereogom microscope with a tracer reflector. Fibre was viewed under the x40 magnification eye piece. Magnified fibres were measured on the screen of the microscope with illumination from 60 watts bulb. Lengths obtained from measured fibres are the magnified lengths, these were converted to actual lengths by dividing its values by the magnification of the eye piece used.

Data Analysis

Treatments in all experiments were laid out in a completely randomized block design with twenty replicates per species. Data collected were subjected to analysis of variance to establish significant relationship between and among the various treatments combinations. Averàge fibre lengths of untreated wood, sawdust and shavings of the stúdied species were compared with those of *Gmelina arborea* and fourteen Nigerian Ṣavanna species as standards. Comparism was done by sawdust and shavings together with those of the standards in different tables, thus making Comparism relatively easy.

Results and Discussions

The result of the findings is presented on tables 1 to 7. Table 1 presents the proportion of the average fibre length of untreated wood, while tables 2-4 present the comparison of the average fibre length of the experimental sample with *Gmelina arborea*. Tables 5-7 present the comparism with fourteen savanna species. On the average, shavings and sawdust represent 94% and 84.3% of the control respectively; these values can also be interpreted as 6.0 and 15, 7 percentage reduction in fibre length for shavings and sawdust respectively as a result of machining. The untreated wood has the longest fibres of 1.1321mm, 1.0660mm and 1.5040mm for *Aningeria robusta, Nesogordonia papaverifera* and *Terminalia ivorensis* respectively. The fibre lengths of wood shavings are 1.0978mm, 1.0361mm and 1.2888mm for *Aningeria robusta, Nesogordonia papaverifera* and *Terminalia ivorensis* respectively while the fibre lengths of the sawdust are 1.0391mm, 0.8694mm and 1.1495mm respectively (Tables 2-4).

Table 1: Proportion of the average fibre length of untreated wood that is represented by that of the treated wood..

Species	Treatment Combinations	Percentages (%)
Aningeria robusta	Untreated versus Shavings	97
	Untreated versus Sawdust	92
Nesogordonia papaverifera	Untreated versus Shavings	99
	Untreated versus Sawdust	83.6
Terminalia ivorensis	Untreated versus Shavings	86
	Untreated versus Sawdust	77.3

Table 2: Comparison of Average Fibre Lengths of Untreated Wood of the Studied Species with That of *Gmelina arborea*

Species	Average fibre length in (mm)
Aningeria robusta,	1.1321
Nesogõrdonia papaverifera	1.0440
Terminalia ivorensis	1.5040
Gmelina arborea.	1.2743

Analysis of variance was based on treatment means. It showed that treatment and species have effect on fibre lengths, there was a significant variation in fibre lengths for the different treatments and to a lesser extent with specie.

Frequency Listributions of Data

Fibre lengths fall into four class limits of 0.5mm class interval; they are 0.00 – 0.5mm, 0.50-1.00mm, 1.00mm-1.5mm and 1.50-2.00mm. Distribution of fibres into class limits varies with treatment. The untreated wood (control) and shavings have the majority of their fibres in the higher class limits, i.e., 1.00-1.50mm. The proportions represented in these class limits is however higher for the control than the shavings. The sawdust fraction has most of their fibres in the lower class limits of 0.50-1.00mm. Table 2 reveals that the average fibre length of the untreated of the studied species and that of *Gmelina arborea* are very close; fibres of both are greater than 1.00mm. Fibre lengths of *Terminalia ivorensis* is longer than *Gmelina arborea* but those of *Aningeria robusta* and *Nesogordonia papaverifera* are shorter than that of *Gmelina arborea.*

Table 3: Comparison of Average Fibre Lengths of Shavings of the Studied Species with that of *Gmelina arborea*

Species	Average fibre length in millimeters (mm)
Aningeria robusta,	1,0978
Nesogordonia papaverifera	1.0361
Terminalia ivorensis	1.2888
Gmelina arborea.	1.2743

Table 4: Comparison of Average Fibre Lengths of Sawdust of the Studied Species with that of *Gmelina arborea*

Species	Average fibre length (mm)
Aningeria robusta,	1.0391
Nesogordonia papaverifera	0.8694
Terminalia ivorensis	1.1495
Gmelina arborea.	1.2743

Table 5: Comparison of Average Fibre Lengths of Untreated Wood of the Studied Species with those of fourteen Savanna Species

S/N	SPECIES	Average Fibre Length (mm)
1	*Bambusa vulgaris**	2.661
2	*Acacia sp.**	1.330
3	*Albiza sp.**	1.351
4	*Lannea acidissima**	1.446
5	*Afzelia africana**	1.600
6	*Prosopis africana**	1.331
7	*Butryospermum parkii**	1.599
8	*Daniella oliveri**	1.249
9	*Pakia sp**	1.498
10	*Parinari kerstingii*	1.550
11	*Mitagyna sp.**	1.546
12	*Anogeisus leocarpus**	1.442
13	*Isoberlina doka**	1.358
14	*Detrium senegalensis**	1.275
15	*Aningeria robusta,*	1.1321
16	*Nesogordonia papaverifera*	1.0440
17	*Terminalia ivorensis*	1.5040

Table 3 shows that the average fibre length of the shavings of the studied species and that of *Gmelina arborea* are very close; fibres of both are greater than 1.00mm. Fibre lengths of *Terminalia ivorensis* is slightly longer than

Gmelina arborea but those of *Aningeria robusta* and *Nesogordonia papaverifera* are shorter than that of *Gmelina arborea*. Table 4 shows that average fibre length of *Gmelina arborea* is longer than those of the fibers of the studied species. Only the fibre lengths of *Aningeria robusta* and *Terminalia ivorensis* are very close to the fibre length of *Gmelina arborea*. The fibre length of *Nesogordonia papaverifera* is less than 1.00mm.

Table 5 shows that fibres of the untreated wood of the studied species and those of the standard are greater than 1.00mm. Fibres of *Terminalia ivorensis* compares favourably with those of *Lannea acidissima*, *Butryospermum parkii*, *Parinari kerstingi*, and Mitagyna spp. Fibres of the remaining tree species are longer than those of the studied species especially *Bambusa vulgaris* which has very long fibres. On the average fibres of the studied species compares favourably with those of the savanna species

Table 6 reveals that fibres of the standard are longer than those of the shavings; the differences between them are not so great. Fibres of shavings like those of standard are greater than 1.00mm. Table 7 shows that fibres of sawdust of the studied species are less than those of the standard. Only fibres of *Aningeria robusta* and *Terminalia ivorensis* are about half as long as those of the standard. Fibres of *Nesogordonia papaverifera* is less than 1.00mm.

Table 6: Comparison of Average Fibre lengths of shavings of the studied species with those of fourteen Savanna Species.

S/N	Species	Average Fibre Length (mm)
1	*Bambusa vulgaris**	2.661
2	*Acacia sp.**	1.330
3	*Albiza sp.**	1.351
4	*Lannea acidissima**	1.446
5	*Afzelia africana**	1.600
6	*Prosopis africana**	1.331
7	*Butryospermum parkii**	1.599
8	*Daniella oliveri**	1.249
9	*Pakia sp**	1.498
10	*Parinari kerstingii·*	1.550
11	*Mitagyna sp.**	1.546
12	*Anogeisus leocarpus**	1.442
13	*Isoberlina doka**	1.358
14	*Detrium senegalensis**	1.275
15	*Aningeria robusta,*	1,0978
16	*Nesogordonia papaverifera*	1.0361
17	*Terminalia ivorensis*	1.2888

Table 7 Comparism of Average fibre lengths of Sawdust of the studied species with those of fourteen Savanna Species.

S/N	SPECIES	Average Fibre Length (mm)
1	*Bambusa vulgaris**	2.661
2	*Acacia sp.**	1.330
3	*Albiza sp.**	1.351
4	*Lannea acidissima**	1.446
5	*Afzelia africana**	1.600
6	*Prosopis africana**	1.331
7	*Butryospermum parkii**	1.599
8	*Daniella oliveri**	1.249
9	*Pakia sp**	1.498
10	*Parinari kerstingii*	1.550
11	*Mitagyna sp.**	1.546
12	*Anogeisus leocarpus**	1.442
13	*Isoberlina doka**	1.358
14	*Detrium senegalensis**	1.275
15	*Aningeria robusta,*	1.0391
16	*Nesogordonia papaverifera*	0.8694
17	*Terminalia ivorensis*	1.1495

Discussions

The results of the study revealed that the hydrogen peroxide had a bleaching effect on the silvers, it turned the slivers to white; the acetic acid acted as the cooking medium with softening action on the silvers. Machining had effect on the fibres lengths. Some of the fibres are crushed or broken in the process of machining, this accounts for the disparity in fibre lengths of Treated and Untreated wood. It was observed that fibres of untreated wood were longer than those of

Treated wood. This is because some of the fibres of the treated wood have been broken while fibres of untreated wood are whole or complete fibres.

Wood shavings have longer fibres than sawdust thus average fibres lengths of wood shavings represents a higher proportion of that of the untreated wood or control than sawdust (Table 2), this is due to the fact that shavings are peered off the wood, thus crushing effect of the planar machine on fibres of shavings is minimal as there is very low tendency for most of its fibres being crushed. Crushing effect of the circular saw on fibres is greater, majority of sawdust fibres are broken which accounts for shorter lengths of its fibres Machining effect is almost uniform for each treatment, that is why fibres length measurements cluster around the mean or average fibres length for each treatment. Analysis of variance confirms the fact that machining has effect on fibres lengths It revealed that treatment or machining effect may vary from species to species due to the fact that different species may have different capacity to withstand crushing effect of the machines on its fibres.

Average fibres lengths of untreated wood of the studied species compare favorably with those of *Gmelina arborea* and fourteen Nigerian Savanna species (Table 5-7) because their average fibres lengths like those of the standards are greater than 1.00mm and are within very close range with those of the standard. Average fibre lengths of shavings also compares well with those of the standards, they are only slightly less. Average fibre lengths of sawdust of the studied species except *Nesogordonia papaverifera* are about half as long as those of *Gmelina arborea* and fourteen savanna species hence, sawdust fibre lengths can therefore be said to be comparable with those of the standard. Wood shavings can be said to be suitable material for making pulp and that the reduction in its fibre lengths due to crushing effect of the planar machine is within limits that can be tolerated for paper production.

For sawdust and shavings to be used like the standards, it may therefore be essential to mix their fibres with long pulp in order to make up for loss in strength and other physical properties that may result from the presence of broken fibres in their pulp. Wood shavings can be used much like the standards for pulp making with very little modification since its fibres are almost as long as those of the standards. Analysis of variance has shown that there is significant difference between the fibre lengths of the standard and those of circular saw treated wood. The fibres produced from sawdust cannot be used for high quality papers and therefore pulp from such source may be directed towards the production of low quality papers such as toilet rolls, container liners, pressed board, etc. this will relieve the pressure placed on high quality pulp and wood species used for producing this type of pulp products.

The untreated (unmachined) wood of the studies species have not been previously investigated for pulp making; this study has therefore established that they can be used much like the standards ,*Gmelina arborea* and fourteen savanna species for paper making as they compare favorably with them. In the final analysis, it can be said that sawdust and shavings are suitable materials for paper making. Also the untreated or un-machined wood of the studied species are suitable for paper making.

Conclusions and recommendations

Machining has effect on fibre lengths, the crushing effect of the planar machine circular saw reduces the length of fibres. The untreated wood has longer fibres than the treated wood because, the latter have some of their fibres crushed in the process of machining. Fibre lengths varies within the treated wood; wood shavings have longer fibres than sawdust due to the fact that crushing effect of the planar machine on fibres is very mild, while the crushing effect of the circular saw on fibre lengths is greater. The fibre lengths of wood shavings are only slightly less than those of the untreated wood or control. The reduction in fibre lengths as a result of machining are within limits that can be tolerated for pulp production for planar shavings. Pulp from sawdust may be used for low quality paper production. The untreated wood of the studied species are suitable species for paper production.

Recommendation

Sawdust and shavings should be explored for paper production in Nigeria. Research should be carried out to establish the pulping characteristics of sawdust and shavings and the paper grades for which they are best suited. Research should also reveal the form the degree of modification like blending with long fibre pulp that should be incorporated into the materials in order to perfect them for the desired uses. Appropriate technology should be developed to process the materials, this because handling by the conventional methods may be unsuitable or difficult. The untreated wood of the studied species have not been previously investigated for paper making, this study has therefore showed that they are suitable species. They should henceforth be included in the list of Nigerian hardwoods that rare suitable for paper making.

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