Bulletin of Science Association of Nigeria Vol. 23 (2000) 169-171

ECOLOGICAL UTILIZATION OF THE WEED – *Tithonia diversifolia* AND SUSTAINABILITY OF THE PAPER INDUSTRY IN NIGERIA

CHUKWUKA, K. S.
Department of Botany and Microbiology
University of Ibadan, Ibadan – Nigeria

Abstract

Tithonia diversifolia is found growing abundantly within the forest zone of Nigeria. The evaluation of the pulp and paper making properties of *T. diverisifolia* showed average fibre length, width, wall thickness and lumen of 827.66 ± 186.40∝μm, 20.29 ± 3.92 ∝μm, 3.96 ± 0.28 ∝μm and 12.16 ± 3.96 μm respectively. This short fibre length and small wall thickness of *T. diversifolia* made it unsuitable for making strong papers. However, it is good material for making newsprints, toilet tissues, serviette papers, packing cartons and egg crates. This will go a long way towards improving the welfare and living conditions of Nigerian given that paper is a civilised material.

Introduction

Although the definition of a weed has been controversial, most workers see weed as a useless and obnoxious plant (Akobundu, 1987; Akobundu and Agyakwa, 1987). The concept of the above definition could be seen from the use a plant could be put to. Fortunately, there is no plant that is not useful to man, it depends on what the individual knows about the plant. This is to say that there is no group of botanical plants called weeds. The word "weed" was coined out by early farmers who observed that certain plants (other than their target crops) interfere with the productivity and yield of their target crops, which were meant for subsistence living. These plants which interfere with the yield of the target crops are agronomically referred to as weeds.

Tithonia diversifolia otherwise called "Mexican sunflower" is an exotic weed recently encountered by most farmers, travellers and scientists within the forest zone of Nigeria. The rate at which the plant is spreading is assuming a worrying proportion. *T. diversifolia*, a robust and erect annual plant, grows very fast (1 – 5m high) and attains maturity within a short time in a growing season. This attribute of the plant suggests that it could be a good material as raw material for paper industries because of its long fibres. Plants with these attributes have shown good potentials as viable raw materials for paper making (Gurumurthy *et al*., 1995; Gehlawat *et al*., 1995; Ali *et al*., 1993).

Today in Nigeria and world-over, the overwhelming increase in human population, awareness and literacy level has increased the demand for paper and pulp. In Nigeria for example, our paper industries depend largely on imported pulps and finished papers (Akpan pers. comm.) thereby reducing their jobs to mere cutting of paper sheets. This is largely due to obsolete machines, lack of raw materials and modern equipment used in processing the raw materials for paper making. This has resulted to the daily increase in the prices of pulp and paper especially when the later is a civilised material without any substitute. This study therefore examines the usefulness of *T.diversifolia* as paper material for the sustainability of the Nigerian paper industries especially at this period of raw material constraints.

Materials and Methods

Collection of Raw Material

Stems of *Tithonia diversifolia* were collected from the Research Farm of the Department of Botany and Microbiology, University of Ibadan, Ibadan; and taken to the Pulp and Paper Laboratory of the Federal Institute of Industrial Research, Oshodi (FIIRO), Lagos to determine pulping characteristics of the plant.

Assessment of Paper Potential of *Tithonia diversifolia*

This was carried out at the Federal Institute of Industrial Research, Oshodi (FIIRO). The areas covered in this assessment include: measurements of fibre length, thickness, of walls, size of lumen and fibre width. Others are pulping of *T.diversifolia* stems, pulp refining or beating, stock preparation, paper making, drying and calendering.

Measurements of Fibre Length, Thickness of Wall, Size of Lumen and Fibre Width of *Tithonia diversifolia*

The stems of *Tithonia diversifolia* were cut into smaller pieces of about 10cm in length. This was immediately followed by debarking of the cut stems which was further sliced into smaller pieces of about 30 mm (length) and 5 mm (width).

These were placed in a round bottom flask containing equal volumes of 50% Hydrogen peroxide (H_20_2) and 99.8% of Acetic acid glacial (CH_2C00H) and refluxed for 48 hours and allowed to cool.
After cooling, the refluxed stems were placed in a beaker and marcerated. After marceration, the fibres were separated and examined with the Recihert "visopan" projection microscope with high magnification of 500. The fibre lengths, thickness of walls, size of lumen and fibre width were carefully measured.

Pulp Evaluation of *Tithonia diversifolia*

Thermo-mechanical pulping process of the sliced stems was employed. This was done using soda. 1126.13g of air dried (AD) wood corresponding to 1000g of oven dried (OD) wood was cooked or digested with 15% of soda (Sodium sulphide) at a liquor to wood ratio of 3.33:1 in a digester for 3 hours at a temperature of 170^0C and pressure of 1.05 bar. The digester was degassed after $1^1/_2$ hours to allow for good penetration of the liquor (as equilibrium position will change in such a way as to account for the waste of the gas) as liquor will penetrate the wood more to account for the loss in gas and thus generate more gas. At the end of the second $1^1/_2$ hours, the digester was switched off and allowed to cool over night before removing the contents.

The above process was repeated using 1013.51g of AD wood, which corresponded with 900g OD wood. This was cooked or digested with 20% chemical at a liquor to wood ratio of 5:1.
In each case, after removing the contents, they were washed clean over running tap water in a sieve. The washed pulp materials were air dried for 2 weeks. After drying, the pulp materials were divided into two, placed into two separate buckets, labelled A and B. The contents of bucket A was used to form unbleached paper while the contents of bucket B was bleached and used in forming bleached paper.

The bleaching process adopted is the Peroxide-Oxidation-Peroxide (POP). This was done in a two stage approach. Firstly, 30ml H_20_2 was added to the pulp placed in a conical flask and heated in a water-bath for 3 hours. After heating, the contents were removed and washed with 5g of caustic soda (Na0H). The bleaching process was repeated after washing for 3 hours, and rewashed clean under running tap water and dried.

Pulp Refining/Beating

After pulping, the air dried pulp realised were mixed with water at a ratio of 3 grams of pulp to 100ml of water and placed in a volley beater. The mixture was beaten for 30 minutes to make the fibres straight. This affords the fibres the property of easy cohesion. Beating operation ensures control of paper formation and optimum strength improvement due to increase in fibre to fibre bonding. Excessive beating will however, lead to fibrillation and loss of strength (Udohitinah pers. comm).

Drying

The paper sheet left on the hand sheet paper former or sample screen is then transferred to an oven and dried at a temperature of 80^0C.

Calendering

Laboratory calendering was done by using a pressing iron to smoothen the surface of the paper formed.

Results

The result showed that *T. diversifolia* has an average fibre length of 827.66 ± 186.00 ∝m; wall thickness of 3.96 ± 0.28 ∝m; lumen 12.16 ± 3.96 ∝m and fibre width of 20.29 ± 3.92 ∝m. The evaluation of 1126.13g of AD wood of *T. diversifolia* for pulping with 15% of soda at a liquor to wood ratio of 3.33:1did not pulp the wood materials. However, with 1013.51g AD wood and 20% of soda at liquor to wood ratio of 5:1 the wood materials pulped (see Table 1). Paper samples formed from *T. diversifolia* showed good formation for both unbleached and bleached papers.

Table 1: Soda Process for Measuring Pulp Properties

%	Wt. of Chem. (g)	Vol. of liquor (l)	Liquor to wood ratio	Chem. to wood ratio	Conc. (g/l)	Wt. of OD wood (g)	Wt. of AD. wood (g)	Pulp Properties		
								YIELD		
								Total Yield (%)	Screened Yield (%)	Reject (%)
15	150	3.33	3.33:1	0.15	45	1000	1126.13	100	5.66	94.34
20	180	4	5:1	0.2	45	900	1013.51	100	98.74	1.26

Discussion

The evaluation of the pulp and paper-making properties of *Tithonia diversifolia*, a fast growing weed, showed inadequately physical strength properties for the unbleached and bleached papers produced. Pulp yield for the unbleached stock was satisfactorily while the yield for the bleached stock was low. The average fibre length, fibre width, fibre wall thickness and lumen of 827.66 ± 186.40 ∝m, 20.29 ± 3.92 ∝m, 3.96 ± 0.28 ∝m and 12.16 ± 3.96 ∝m respectively were recorded for *T. diversifolia.* The yield obtained from the pulping process suggests that high pulp yield could be obtained from *T. diversifolia* but the short fibre length, small fibre width would be unsuitable for making strong papers. Mahmood (1993) working on *Casuarina equisetifolia* reported similar findings. Guritno *et al*., (1995) and Udohitinah (Personal communication) argued that plants with short fibre length and small fibre width are not good paper materials. It was therefore not surprising that laboratory handsheets with inadequate strength properties were obtained. Unfortunately, tests like tearing resistance, air permeability, smoothness, opacity and brightness could not be carried out due to lack of equipment.

Conclusion

In paper making, the principal factors which determine if a plant is paper material are: suitability of fibres, dependability of supply, cost of collection, transportation, preparation and tendency to deteriorate in storage. From the above, *T.diversifolia* satisfies over 60% of these factors and as such will be recommended as alternative source of raw materials for pulp and paper making. This is in recognition of the fact that bleached pulp from *T.diversifolia* will be suitable for making good newsprints, serviette and tissue papers while unbleached pulps for making (packing) cartons and egg crates as against the cycling of used and waste papers as is the case in India and Europe today.

References

Akobundu, I.O. (1987): Weed Science In The Tropics. Principles and Practices. John Wiley & Sons Singapore. 522 pp.

Akobundu, I.O. and Agyakwa, C.W. (1987): A Handbook of West African Weeds. A publication of International Institute of Tropical Agriculture, Oyo Road, Ibadan – Nigeria 521 pp.

Ali, F; Sarma, T.C. and Saikia, C.N (1993): Pulp and paper from certain fast –growing plant species. Bioresource Technology 45(1): 65 – 67.

Gehlawat, J.K; Singh, G.B. and Solomon, S. (1995): Development of integrated sugar-paper-alcohol complexes in India. Sugarcane-agro-industrial-alternatives 39: 495 – 505.

Guritno, P; Darnoko; Daswir and Soetrisno (1995): Production of Kraft paper made from oil empty fruit bunches on pilot scale. Jurnal-Penelition-Kelapa-Sawit (Indonesia) 3 (2): 134 – 138.

Gurumurthy, B.S; Singh, G.B. and Solomon, S (1995): Sugarcane bagasse: a potential and viable raw material for paper. Sugarcane-agro-industrial-alternatives 3: 67 – 78.

Mahmood, A (1993): Suitability of *Casuarina equisetifolia* wood for pulp and paper industry in Pakistan. Pakistan Journal of Botany 25 (2): 179 – 182.

Bulletin of Science Association of Nigeria Vol. 23 (2000) 169-171