Utilization of Banana Tree Wastes in Mechanical Pulps paper Making

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ABSTRACT

The different characteristics of the paper obtained from the banana stems and their mixtures with secondary fiber have been analysed.

The traditional procedures for mechanical pulping have been modified by means of partial elimination of the juices before the slushing state. This modified method gives better results.

The characteristics of the paper obtained show that the best application of the banana stem could be as a joint filler.

INTRODUCTION

The present develoment of the paper industries demands the use of new methods to obtain the pulp paper and makes necessary to look for new raw material, not only from conventional sources (which are in decline) but also from seasonal plants and other type of vegetables waste.

Hubnez (1) in 1970 studied for the first time the use of the banana tree as a raw material to obtain pulp paper using an alkaline method. From that moment, several workers have obtained pulp paper from banana tree, but it was only in 1960 when Guha (2) obtained paper in the laboratory from the stems of the "Musa sapientum". The yield was low and the authors suggests to improve the method by using a mild digestion.

Moisev, Bourvich and Duborag (3) in 1968, found that the problems showed by the chemical pulp of the banana stems (i.e. slow drainage rate) could be reduced to a minimum with a pretreatment which had the followed steps:

- partial elimination of the moisture.
- cutting of the fibre.
- cleaning of the unwanted substancies.

At the present moment, the process used to obtain pulp from banana tree are mainly chemicals, alkaline or neutral. Heikal and Falde (4) in 1977 treated the banana stems by the method of the neutral sulfite.

In 1980 Kurita and Ogawa (5) applied a sulfite pulping to fibres of banana leaves. and Yamczaki and Kurita (6) obtained pulp from several species of "musas" by a sulfite method.

Dhake and Lapkal[7] in 1983 used a sodium hydroxide method to treat the stems and leaves of the "Musa Cavendish".

Sala and Torrets[8] obtained pulp using bananas stems and the sodium hydroxide method with very mild conditions. These authors found a very low yield the same that the others results that have been presented above.

The aim of this work is to study the characteristic of the pulp obtained from the banana tree wastes. The selection of this raw material is due to the following reasons :

- The banana tree is a seasonal plant that gives about one million Tonn/year of waste in the Canary Island.
- This could be an interesting raw material to be used in the Canary paper Industry. At the present time 60% of the exports products are taken in a carton boxes which are constructed from mechanics

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pulps obained from recycle paper that is all imported.

Pulping Method

There are many different manufacturing processes involves in the conversion of wood to pulp paper : chemical, semichemical, mechanical and mechanical with water vapour.

The selection of the method to use must have in consideration the nature of the raw material. With this in mind the structural and chemical analysis of banana waste have been preformed and the results are presented in table I.

TABLE—1

Chemical characteristics and composition of the dry material (%)

Solubility in NaOH	53.87	64 57
,, ,, cold water	18.97	39.32
,, ,, hot water	21.23	44.75
,, ,, alcohol-benzene	2.95	2.98
,, ,, ether	0.40	—
Moisture	7.12	12.94
Lignin	7.42	7.80
Pentosan	11.79	12 21
Holocellulose	57.38	48.64
Ashes	13.96	30.78
Rough protein	0.80	—

The analysis have been made for two different sections of the banana stem, the inside and the outside. The most outstanding results are the high amount of moisture found, 90% in the inside and 93% in the outside. From Table I, it can be observed the following aspect :

1. The raw material is very little lignify.
2. The amount of holocellulose is lower than in other raw material.
3. The solubility in cold and hot water is very high which means a high amount of sugars and pectin.
4. The solubility in sodium hydroxide is anormaly high probably due to a very high contented in hemicelluloses.
5. The amount of minerals salts (ashes) which are not retained is high.
6. The amount of rough fibre is only 35%.
7. The rough fibre is very large (same time as larger that the stem) and is very flexible.

The rough fibres are formed by elemcntals small fibres of 1 to 3.3 mm length and 10 to 25 mm width. These fibres have a very high capacity for compaction and give resistance pulps and they represented only a 1.8% of the dry material.

Therefore the mechanical pulps seems a better alternative than the chemical pulps.

Experimental procedures

The flux diagram for the experimental procedures for mechanical pulps, is shown in Fig.I

The slushing is the fundamental step of the processes and the apparatus used for it, was a "Spront Waldron, 12".

In same experiments, the procedure was modified by means of pretreat the raw material with water vapour before the slushing state.

The slushing experiments were carried out with a 16381 disk with 1.27mm of separation between disks. When the whole banana tree stem was used the sheets were impossible to obtain, due to the formation of lumps.

To try to improve the material, a separation between sheets of 9076mm was used, but even in that conditions was impossible to obtain the pulp sheets.

The pulp obtained from the banana stem was mixed with secondary fibre and the characteristics of the sheets formed, are shown in Table II.

TABLE—II

A = Banana

B = Secondary Fiber

	A–80% B–20%	A–70% B–30%	A–60% B–40%
Basis weight	154.4	149.3	148.4
Specific Weight	0 45	0.46	0 48
Breaking length SL, m	1813 0	1887.0	1856.0
Stretch	0.60	0.72	0.66
Bursting strength	1389.6	10+5.1	1335.6
Tearing strength	16366.4	23290.8	18995.2
Folding endurance	2.0	4.0	6.0
Concora Medium Test (C.M.T.)	7.44	8.25	6.25

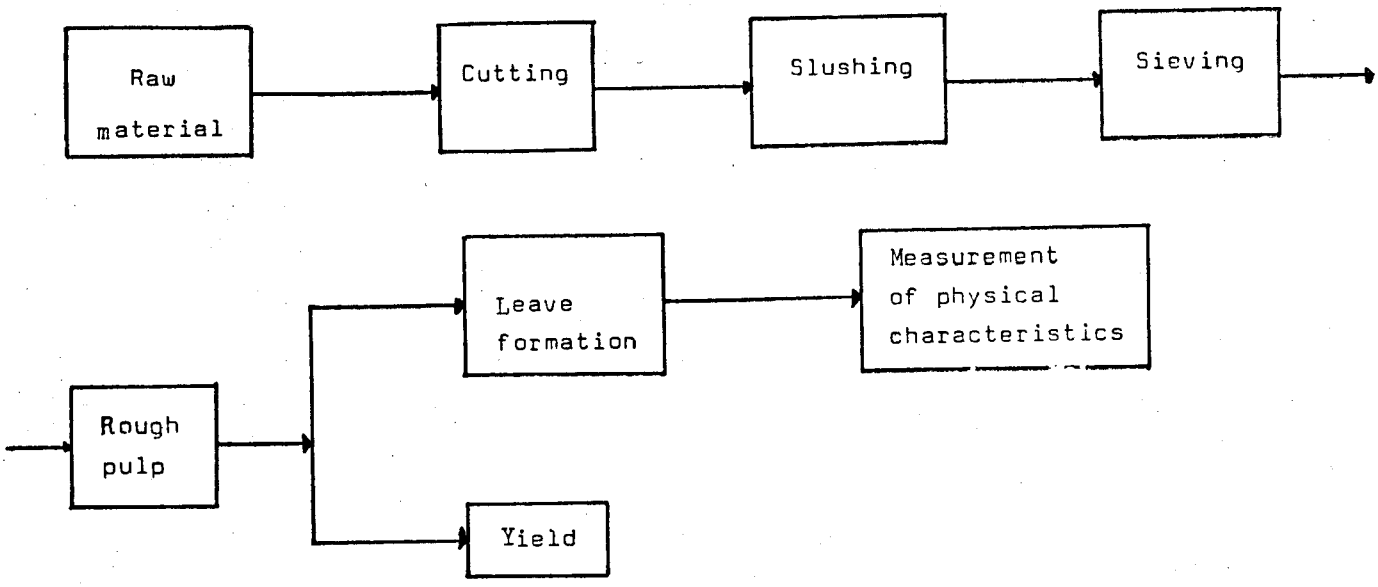

FIG.—I

To avoid the difficulties observed when the whole stem is used, the inside and outside layer of the banana stem were separated and studied independently.

Study of the inside of the stems

Two different type of slushing experiments were carried out with the inside of banana tree stem using two disks, the first with 0,1674 mm of separation between sheets (disk, C-2976, Exp I), and the second with 0,127mm (disk 16381, Exp II) with yield of 44,6 and 53.78% respectively.

With the second disk the raw material was used alone and mixed in different proportion with secondary fiber. The results obtained are presented in Table III

The important parameters for determine the quality of the paperboard are : the breaking length, bursting and tearing strength. FromTable III can be seen that these characteristics are low, in all the cases, with no improvement when secondary fiber was added.

A bursting strength of 2473 in Exp I becomes to 2048 in the 70% mixture, but the tearing strength remains aproximately constant at a value of 12981 and the breaking length at a value of 3000, inside the accepted value in paperboard pulp.

The Concota Medium Test is the determining characteristic in the pulps used in the manufacture of corrugated cartons, and Table III shows a maximum value of 18,18 when a 20% mixture of secondary fiber and banana tree are used, but this value is still too low.

An experiment was carried out by passing water vapour through the raw material before the slushing state, and the yield was of 20.75%. The results are shown in Table IV.

TABLE—III

A=Banana

B=Secondary fiber

	Exp I		Exp II		
	A—100%	A—100%	A—80% B—20%	A—70% B—30%	B—100%
Basis weight	145.5	157.9	157.7	157.6	141.4
Specific weight	0.51	0.51	0.49	0.52	0.58
Breaking length SL, m	2965.0	3250.0	3061.0	3054.0	3877.0
stretch	1.4	0.99	0.87	0 83	2.1
Bursting strength	2473.5	2210.6	2050.1	2048.8	2686.6
Tearing strength	11640.0	12789.9	11985.2	13080.8	1512.6
Folding endurance	—	5.0	4.0	4.0	33.0
Concora medium test (C M.T.)	14.90	15.00	18.18	17.60	13.94

TABLE—IV

A=Banana

B=Secondary fiber

	A—70% B—30%	A—60% B—40%
Basis weight	153.0	141.0
Specific weight	0.43	0.57
Breaking length SL, m	1779.0	1841.0
Stretch	0.98	0.66
Bursting Strength	922.8	987.0
Tearing Strength	10766.0	9165.0
Folding endurance	2.0	2.0
Concora Medium Test (C.M.T.)	12.4	11.65

Study of the outside of the banana tree stem

The results obtained when the outside layer of the stem were used, are shown in Table V for different mixtures of stems and secondary fiber.

The yield was 50. 30%, when the raw material was not pretreated and 40.57% when was pretreated with water vapour during 15 minutes.

From the results obtained can be seen, that the physical characteristics are better and the yield is higher when the whole stem is used, and the difficulties to make the sheets have not beeu improved.

Therefore, it was decided to use the whole stem, but only after a pretreatment for the parcial elimination of the juices. The slushing was carried out in a C-2976 disk with 0,0762mm of separation, between the disks; the yield was 47.37%.

The drainage rate of the pulp was improved and it was possible to make a pulp sheet. The physical characteristic of the sheet obtained from the banana stem, and different banana and secondary paper mixtures are shown in Table VI.

When the secondary paper proportion increases, the physical characteristics increase too, but the C.M.T. decreases.

From the results presented in Tables II to VI can be concluded that it is necessary to pretreat the raw material to eliminate the juices, to be able to improve the pulp quality.

Conclusion

From the present study can be drawn the following conclusions :

— The mechanical procedure, without water vapour pretreatment, is the best to obtain pulp sheet, but with a previous partial elimination of the plant juices.

— To improve the economy of the process, could be interesting to found a suitable use of the above juices.

TABLE—V
A = Banana
B = Secondary fiber

	A—70% B—30%	A—60% B—40%	A—70% B—30%	A—60% B—40%
Basis weight	142.0	147.4	131.5	140.1
Specific weight	0.45	0.47	0.53	0.50
Breaking length SL. m	1284.0	1433.0	1351.0	1565.0
Stretch	0.74	1.2	0.66	0.83
Bursting strength	994.0	1326.6	1052.0	1401.0
Tearing strength	10508.0	11644.6	13150.0	15551.1
Folding endurance	2.0	3.0	5.0	8 0
Concora medium test (C.M.T.)	8.19	8.79	8.34	8.71

TABLE—VI
A = Banana
B = Secondary Fiber

	A—100%	A—75% B—25%	A—55% B—45%	A—40% B—60%
Basis weight	163	163.3	160.5	160.5
Specific weight	0 44	0.53	0.52	0.54
Breaking length SL.m	2378.0	2334.0	2490.0	3065.0
Stretch SL.%	0.94	1.0	1.6	2.1
Bursting Strength	978.0	1633 0	2247.0	2889 0
Tearing Strength	4727.0	10451.2	14927.0	19260.0
Folding endurance	1.0	2.0	11.0	44.0
Concara Medium Test (C.M.T.)	17.92	13.57	12.21	10 45

— The pulps physical characteristics are modest even in the best of the cases; so it can be only used as a joint filler.

— When a banana stem with secondary fiber mixture is used, the pulp quality is greatly improved.

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