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EVALUATION OF PAPER MAKING CHARACTERISTICS OF BAGASSE FIBER IN RELATION TO INDIAN HARDWOODS

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Abstract:

The fibrous raw material supply is rapidly depleting both in quantity as well as in quality. Many mills, which were designed to produce pulp and paper based on conventional raw materials, are forced to utilise pulps from different raw materials. Among the non wood fibers available to paper industry, bagasse has come to stay as a viable alternative. However, the fiber strength, fiber length, and inter fiber bonding of bagasse pulps differ from those of bamboo and hardwood pulps because of difference in morphology.

A comaprative study of the fiber strength, fiber length, and inter fiber bonding characteristics of pulps derived from bagasse with those of hardwood pulps is carried out. The hardwoods chosen for the invetigation are eucalyptus tereticornis, acacia arabica, acacia decurrens, and erythrina suberosa.

The fiber characteristics mentioned above (for various pulps) are determined by short span tensile analysis using pulmac trouble shooter.

Inspite of a marginal difference in fiber strength index and fiber length index, bagasse pulp has considerable high fiber bonding index. The fiber bonding potential of bagasse fiber can be exploited in paper making as it is one of the strongest plus points which will reflect in good formation, low porosity and rattle. It has been experienced that papers made with bagasse pulps and their blends possess superior varnishable charateristics.

Introduction

The rapid decrease in the availability of forest based fibrous raw materials for paper making has necessitated the search for viable alternative raw materials. Sugarcane bagasse has emerged as the best suited among various alternative raw materials, in view of its ready availability at one point (sugar mill), and the development of various scientific methods for storage.

It is reported earlier[1] that the sulphidity in the cooking liquor has a positive role in improving the characteristics of pulp, which is being exploited by the large integrated paper mills, adopting sulphate pulping process. It is estimated that within a couple of decades, 2-3% of total world pulp production will be from this raw material[2].

A typical proximate analysis of bagasse is given in Table 1.

The percentage of non cellulosic material vary based on the cane species, soil and weather conditions, age of cane, harvesting method, cane cleaning and milling methods which have a great effect on bagasse composition.

Bagasse fiber

The morphology of bagasse fiber, as reported by ealier workers, is different from other wood fiber. However, the fiber length of bagasse pulp is in the same range of the fibers from hardwoods. The bagasse fibers are comparatively thin walled. This property results in fiber collapsibility and better consolidation of the sheet.

The characteristics of the finished product (paper) depend upon, besides process variables, the nature of fiber chosen, its load bearing capacity, the fiber length and the fiber bonding potential. The methods for measuring these basic parameters are too complex and time consuming.

W.F. Cowan, in his publications[3], has cited some fundamental methods for determining these parameters. The present paper highlights the paper making characteristics of bagasse pulp namely fiber strength, fiber length and fiber bonding indices in comparison to other forest based fibrous raw materials which are presently used by the papaer makers. The raw materials selected for comparative study are *eucalyptus tereticornis, acacia arabica, acacia decurrens and erythrina suberosa.*

Results and discussions

Breaking length (km), a measure of tensile strength, is plotted against increasing span (mm) for various pulps in Figures 1 to 5. the pulps of raw materials studied (unbleached and bleached) at a freeness of 300 ml CSF recorded marginal drop in tensile strength with increase in span in the dry stage. However, the drop was considerable in wet condition with increasing span in all the cases studied. This may be because of the consideration that the fibers are in non-bonding state in a wet sheet. Bagasse fiber has recorded significant drop in tensile strength in wet condition. The fiber strength of all pulps (expressed as breaking length in km) is obtained by extrapolating the curves to Y axis which represents the zero span. This is also termed as true zero span strength. In the case of bagasse, the junction of west and dry curves did not meet at zero span point. This may be attributable to the presence of high percentage of fines produced during refining. In this case, the fiber strength index is taken as the average of dry and west zero span strengths.

Fiber bonding

The bagasse fiber has exhibited the highest fiber bonding potential (96-97%) in bleached as well as unbleached conditions when compared to other wood fibers at a freeness level of 300 ml CSF. This point becomes obvious when the data given in Table 2 nd the Fig. 6 are examined carefully. Tensile index, which is believed to be dependant upon bonding nature of a fiber is also higher for bagasse. This may be attributable to the thin walled nature of the bagasse fiber contributing to the higher extent of fiber collapsibility. Further, it is possible that the fines may be filling the interstices contributing to better compactness in the sheet leading to a close formation resulting in low porosity of paper made out of bagasse pulp. Experience has proved that, the low porosity and higher compactness of paper made out of bagasse (or its blends) makes the surface impervious to certain solvents and makes it suitable for varnishing after printing.

Wood pulps exhibited the fiber bonding potential in the range of only 70-88%. It may also be noticed that fibers of acacia decurrens had recorded least fiber bonding potential among the pulps studied.

Fiber length

Unbleached and bleached bagasse pulps have the lowest fiber length indices compared to other wood raw materials.

The fiber length indices of the wood pulps fall in the range of 0.19 to 0.3 mm whereas those of bagasse pulps are varying from 0.125 to 0.175 mm. The effect of this lower fiber length index is clerly reflected in a compartively low tear index in case of both unbleached and bleached bagasse pulps. Further, the low fiber length indices of bagasse pulps may be accounting for a rapid fall of wet short span tensile curves with increasing span.

Fiber strength

Besides other factors, fiber strength is one of the major factors contributing towards the strength characteristics of a sheet. The fiber strength index of unbleached wood fibers was in the range of 17.0 to 21.0 km compred to 10.8 km for bagasse pulp. The fiber strength index of bleached wood fibers was in the range of 14.0 km compared to 9.90 km for bagasse pulp. The acacia decurrens (wattle) fiber, despite its higher strength index, did not develop corresponding tensile strength possibly because of its low bonding potential, whereas bagasse fiber despite its low fiber strength index was capable of developing high tensile strength because of its superior bonding potential. This clerly illustrates the way to exploit the fiber bonding potential of bagasse to manufacture papers of high tensile strength. However, in the case of wood fibers, the fiber strength is contributing towards achieving an improved tering index.

Experimental

Hardwood chips were pulped in a laboratory CCL digester to a kappa number of 28 + 1, maintaining a H Factor of 1320. Bagasse (pith content 21 %) was pulped to a kappa number of 15, maintaining a H Factor of 515. All the unbleached pulps were bleached to a brightness level of 77 + 1 % ISO using C,E/H, H bleaching sequence.

The unbleached, as well as bleached pulps were refined in PFI mill following SCAN C 24.67 standard method. Relevant TAPPI standards were followed for making and testing of hand sheets.

The zero/short span testing and analysis was carried out as per Pulmac Instruments instruction manual and as per procedures laid down at reference 4.

Conclusions

1. At the usual operating level of freeness (300 ml CSF), bagasse fiber has superior potentiality for fiber bonding compared to wood fibers, namely, eucalyptus tereticornis, acacia arabica, acacia decurrens and erythrina suberosa. Th is bonding potential has also helped in achieving higher tensile index inspite of unfavourable fiber strength. Because of its superior bonding potential, paper containing bagasse or its blends is characterised by low porosity and better varnishability.
2. Acacia decurrens (wattle) fiber is characteised with lower strength properties despite its higher fiber strength index. Hence, care should be exercised while using this raw mateial for making papers of good tensile and tearing strength.

Acknowledgement

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References

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TABLE 1

PROXIMATE ANALYSIS OF BAGASSE

SL. NO.	PARTICULARS	UNIT	INDIAN BAGASSE
1.	ASH	%	2.90
2.	SILICA	%	1.00
3.	SOLUBILITY IN		
	(i) HOT WATER	%	2.20
	(ii) 1 % CAUSTIC	%	30.70
	(iii) ALCOHOL-BENZENE	%	2.50
4.	ACID INSOLUBLE LIGNIN (ASH CORRECTED)	%	21.70
5.	HOLOCELLULOS	%	62.70
6.	PENTOSANS	%	19.20

Note: ALL Results are expressed on o.d. basis

Source : Laboratory evaluation of Australian bagasse for manufacture of bleached chemical pulp, SPB Projects and Consultancy Division, Madras, India, July (1987), Private Communication.

TABLE 2

PROPERTIES OF HAND SHEETS (3000 ML CSF)

PROPERTIES	UNIT	BAGASSE		EUCALYPTUS TERETICORNIS		ACACIA ARABICA		ACACIA DECUR RENS		ERYTH RINA SUBEROSA	
		UNBLD	BLD	UNBLD	BLD	UNBLD	BLD	UNBLD	BLD	UNBLD	BLD
BULK	cc/g	1.37	1.38	1.81	1.80	1.72	1.74	1.50	1.63	1.64	1.50
BURST INDEX	KPa m²/g	4.37	4.48	4.04	3.58	3.84	3.59	3.65	2.64	4.48	4.03
TEAR INDEX	mNm²/g	4.84	4.83	6.99	6.58	9.53	8.52	6.59	5.33	9.51	8.91
TENSILE INDEX	Nm/g	68.48	68.36	65.66	56.98	58.42	56.82	60.49	49.15	64.64	58.29
STRETCH	%	2.8	3.0	3.4	3.1	3.8	3.8	2.9	2.7	3.9	3.8
POROSITY	ml/min	30	50	1200	1400	1400	1500	1300	1900	200	350
SCATTER-ING CO-EFFICIENT	cm²/g	--	205	--	480	--	390	-	335	--	360
ZERO SPAN ANALYSIS											
FIBER STREN-GTH INDEX	km	10.8	9.9	19.8	18.0	17.0	14.0	21.0	19.0	17.0	15.8
FIBER LENGTH INDEX	mm	0.175	0.125	0.235	0.215	0.300	0.247	0.225	0.190	0.270	0.220
FIBER BONDING INDEX	%	97	96	79	80	80	88	70	77	83	86

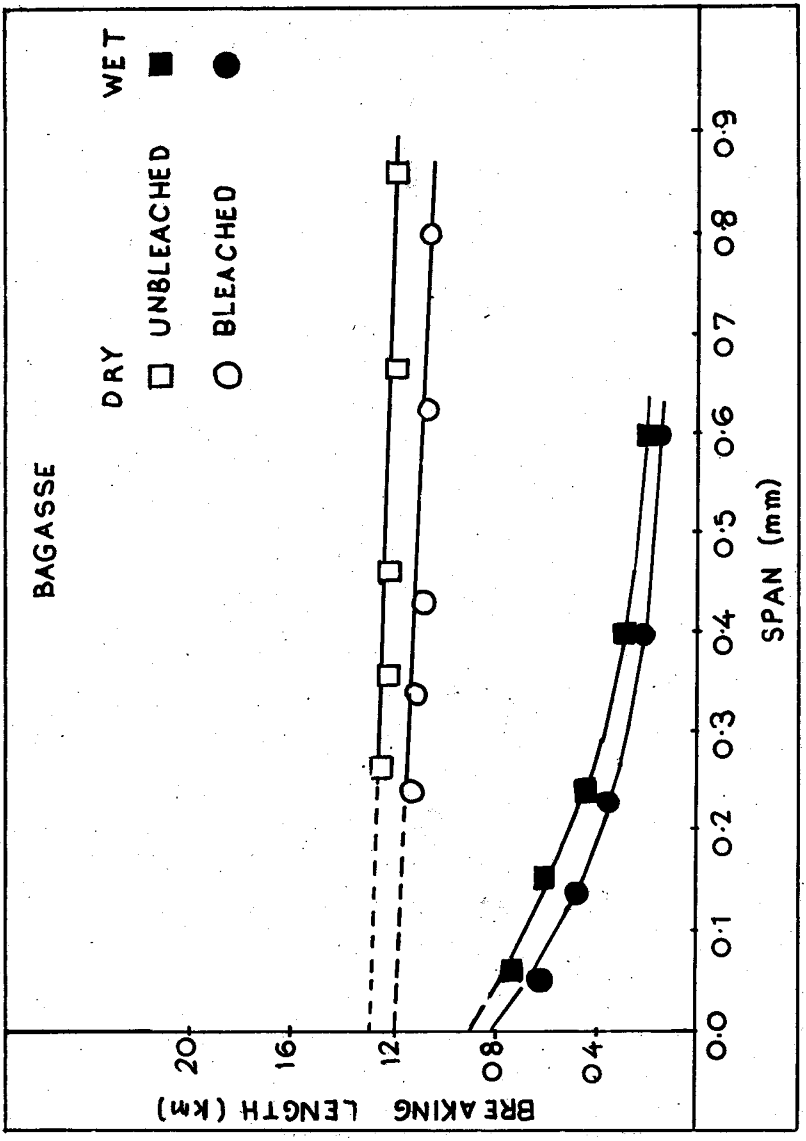

FIG.1 BREAKING LENGTH.(km) Vs SPAN.(mm)

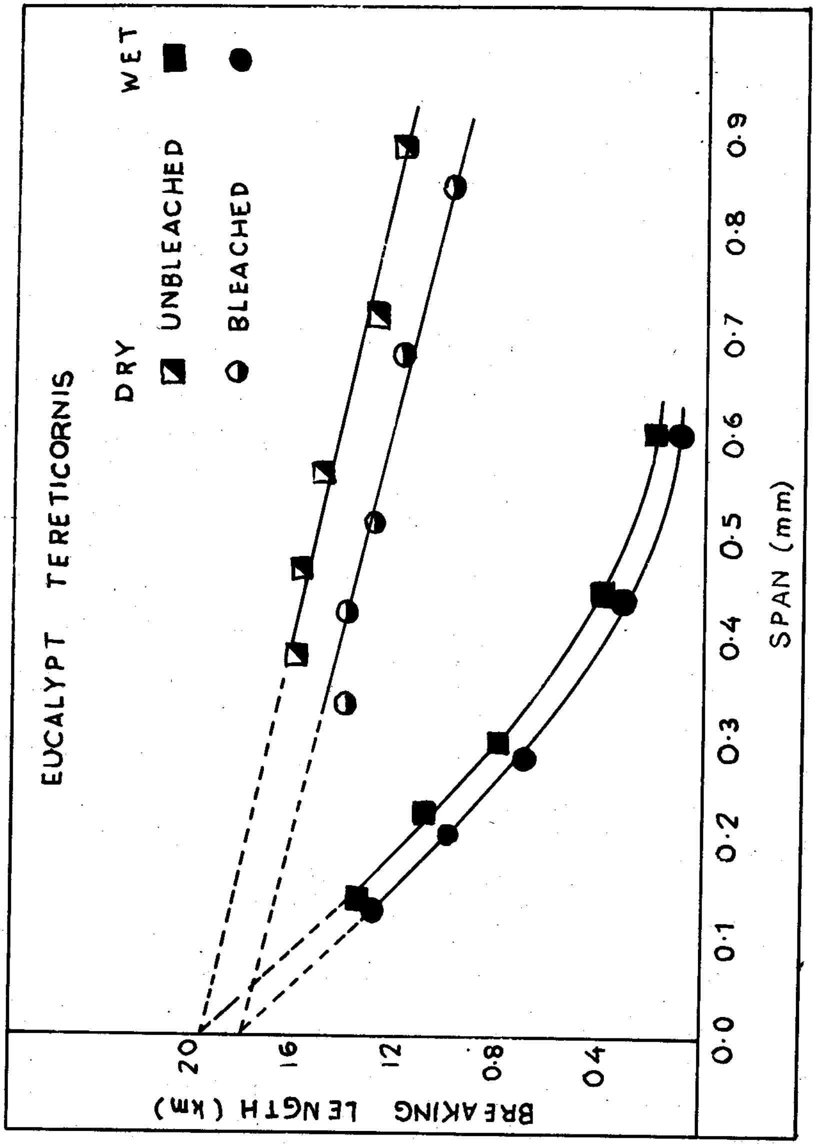

FIG.2 BREAKING LENGTH,(Km) Vs SPAN,(mm)

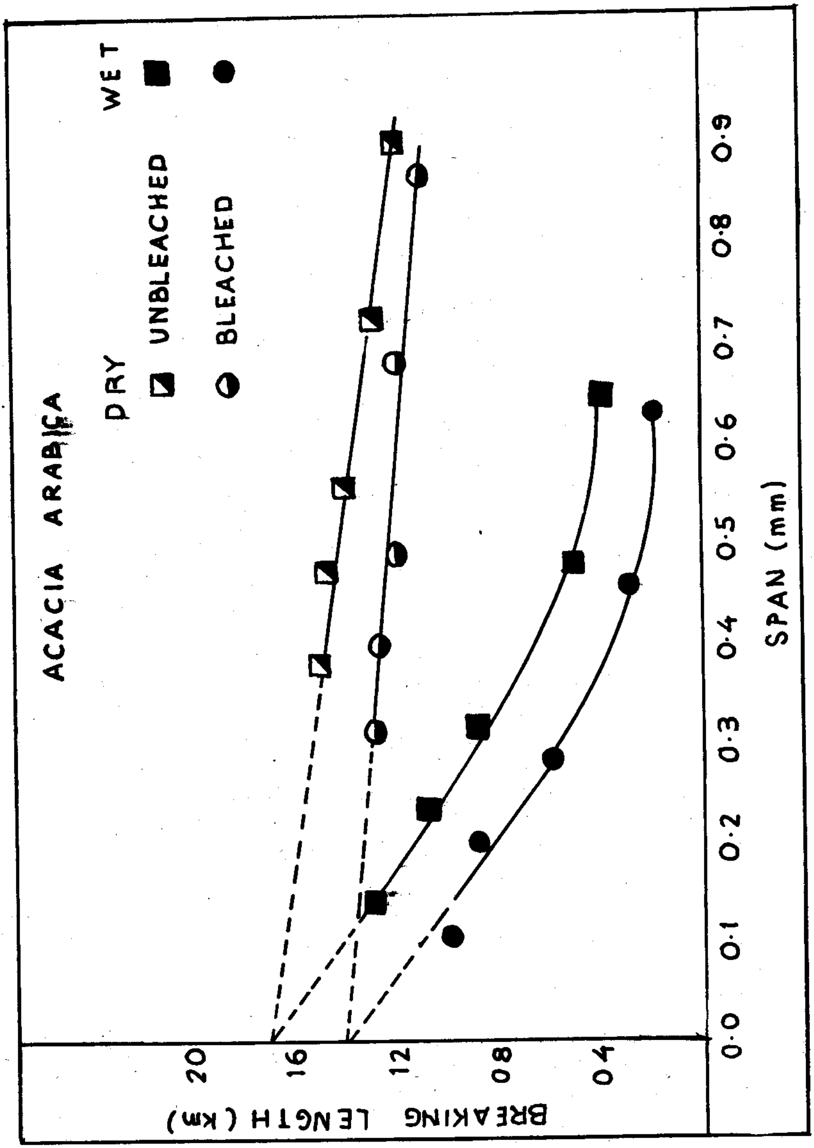

FIG.3 BREAKING LENGTH,(km) Vs SPAN,(mm)

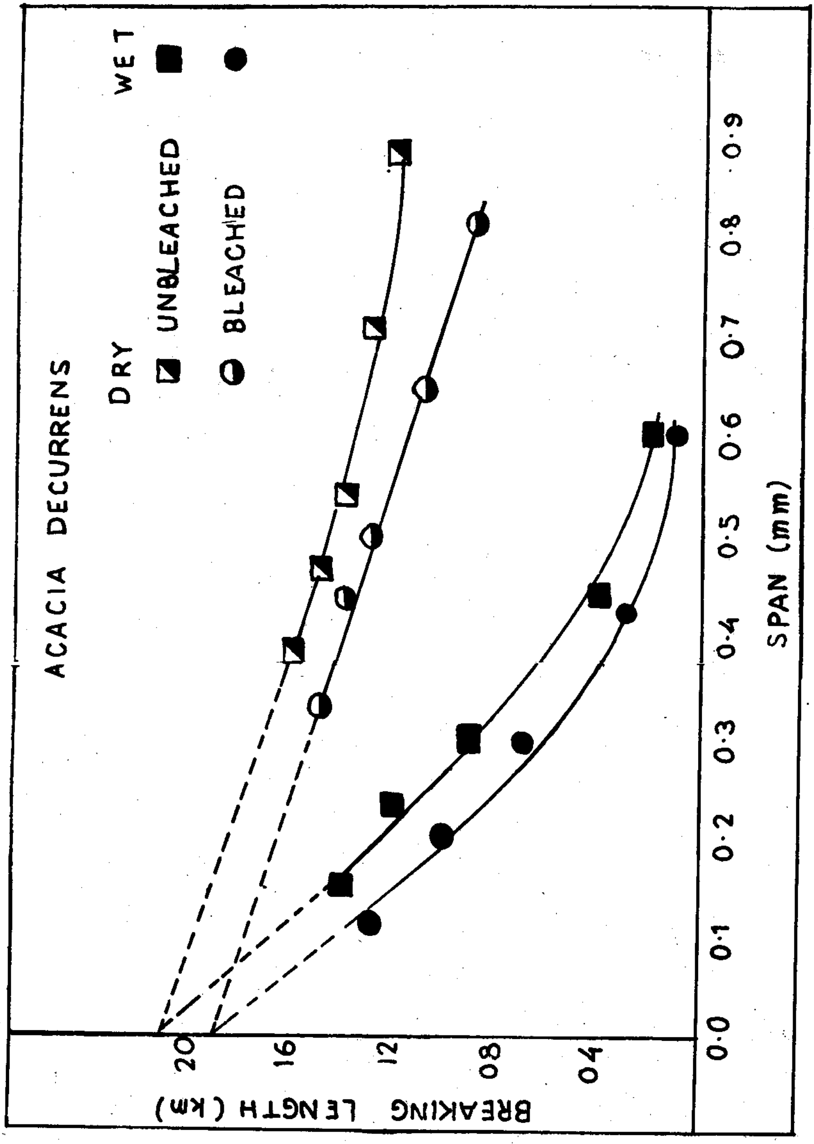

FIG. 4 BREAKING LENGTH, (km) Vs SPAN, (mm)

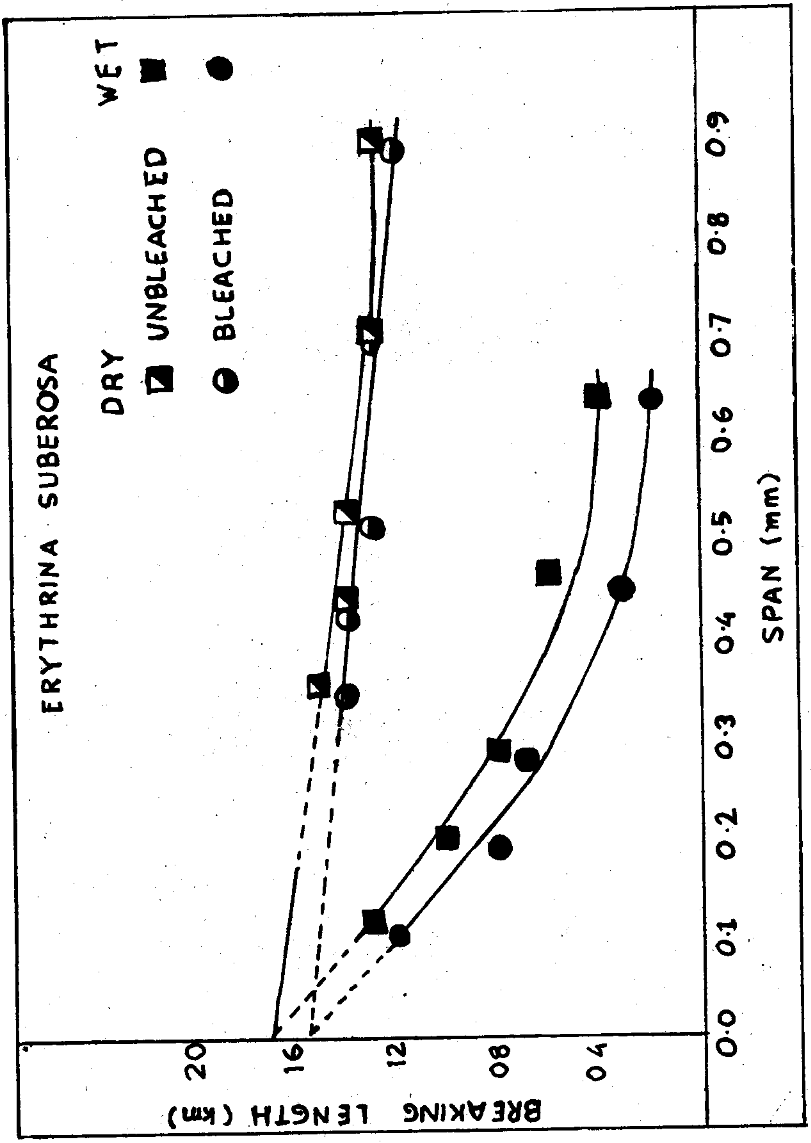

FIG.5 BREAKING LENGTH.(km) Vs SPAN.(mm)

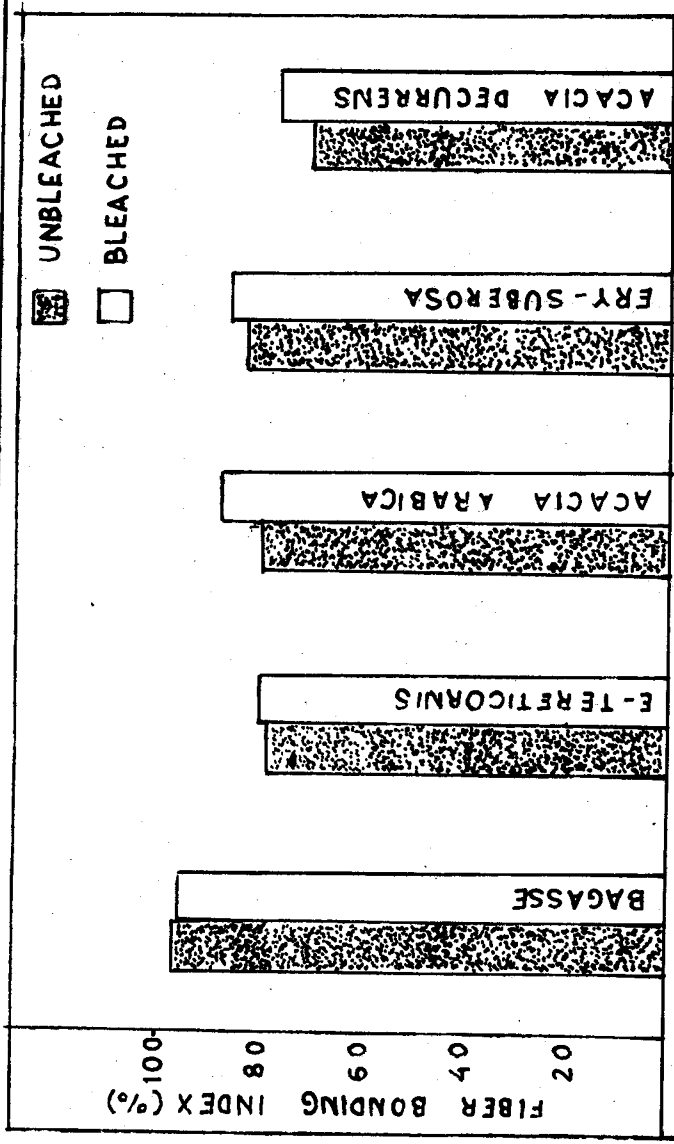

FIG 6 FIBER BONDING INDICES OF VARIOUS PULPS (300 ml CSF)