Comparison of *Eucalyptus tereticonis* and *Anthocephalusindicus* as raw material for Pulp and Paper making

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Abstract-The Paper industry is divided into three main sectors based on the raw material i.e wood based, agro based and recycled fibre based mills contributes 19 %, 10% and 71 % respectively to the total production (Anonymous -2017). The wood based paper industry get their supply from social and agro farm forestry. The Eucalyptus is main hard wood for paper makingEucalyptus is always matter of debate among ecologist regard its impact on ecology. Eucalyptus is toxic due to alleopathic properties, which reduce other plant by restricting germination of other species and is also detrimental to soil micro and macrofauna. *Anthocephalusindicus*, indigenous species may be used as alternative raw material in place of Eucalyptus. After different proximate chemical analysis *Eucalyptus tereticornis* and *Anthocephalusindicus* was subjected to kraft pulping using 10, 12, 14, 16 and 18 % active alkali as Na_2O at 23.0 % sulphidity level. The pulps obtained from different alkali charge were evaluated for strength properties Apparent Density, Tensile Index, Tear Index Burst Index. The results of was different proximate chemical analysis, pulp yield , kappa Number, strength properties was discussion in adequate length of paper

Key words: *Eucalyptus tereticornis Anthocephalusindicus* Kappa number, Klason lignin, strength properties

INTRODUCTION

Paper is one of the basic human needs and paper industry is one of the core industries. Paper is use as index of advancement or development of any society. Paper making is one of the greatest invention of China, was invented in the western Han dynasty (202BC- 9 BC) and improved in the easternHan dynasty (25-220AD) (Ghori et., al 1966). In India, it was the Mughals who introduced the traditional paper makers- the Kagzi's. The first modern paper mill was set up in India in 1832 in Secrampur, West Bengal using mechanized process for papermaking. The Paper industry is divided into three main sectors based on the raw material i.e wood based,agro based and recycled fibre based mills contributes 19 %, 10% and 71 % respectively to the total production (Anonymous -2017). The wood-based paper industry get their supply from social and agro farm forestry. The Eucalyptus is main hard wood for paper making. *Eucalyptus tereticornis* has an extensive natural distribution in a long strip about 100 km wide, from southern Papua New Guinea and the northern tip of Queensland to southern Victoria along the east coast of Australia. In India Eucalyptus was first introduced in 1843 in Niliris. Nowit is cultivated in the different states of India. India over 500000 ha have been planted. (Agarwal, et al., 2017). Eucalyptus is always matter of debate among ecologist regard its impact on ecology. Eucalyptus is toxic due to alleopathic properties, which reduce other plant by restricting germination of other species and is also detrimental to soil micro and macrofauna. *Anthocephalusindicus* may be used as alternative raw material in place of Eucalyptus. As *Anthocephalusindicus* is indigenous species and very good species for making writing an printing paper falling under the category of wood giving more than 48.6 % yield and over 6000m breaking length. In present study Comparison of *Eucalyptus tereticonis* and *Anthocephalusindicus* as raw material for Pulp and Paper making can be perform. Results are discussed at adequate length in the paper (Anupamet al., 2015).

EXPERIMENTAL

Raw Materials: Eucalyptus *tereticornis* has an extensive natural distribution in a long strip about 100 km wide, from southern Papua New Guinea and the northern tip of Queensland to southern Victoria along

the east coast of Australia. It was one of the first eucalypts exported from Australia and is now cultivated throughout the tropics, on a large scale in India. The heartwood is pale to dark red, and fairly well demarcated from the grey to cream-colored sapwood. The grain is wavy or interlocked, texture even and fairly fine. The wood has a density of 660–1060 kg/m³ at 12% moisture content, but wood from plantations often has a lower density than that from natural stands. Evergreen, large tree up to 50 m tall; bole relatively short, straight, up to 200 cm in diameter; bark surface white, grey or grey-blue, decorticating over the whole trunk in large plates or flakes to leave a smooth or mat, mottled surface; crown fairly open. *Eucalyptus tereticornis* occurs from 6–38°S latitude, and climatic conditions in its natural range vary greatly. Rainfall distribution varies from monsoonal with marked dry and wet seasons in southern Papua New Guinea, a summer rainfall climate with a very dry winter in Queensland, and an even distribution of rainfall in southern Queensland, to a dry summer and cold, wet winter in eastern Victoria. It is successfully planted in areas with a mean annual temperature of 14–27°C, a mean maximum temperature of the warmest month of 22–42°C, a mean minimum temperature of the coldest month of 0–19°C and a mean annual rainfall of 400–2300(–3500) mm, with a dry season of up to 8 months. In the drier parts of this range it is grown in temporary flooded locations or with irrigation. In southern China and Pakistan adapted selections are reported to survive temperatures as low as –7°C. The wood is used for construction, railway sleepers, bridges, wharves, poles, piles, posts, boats, mine props, boxes, hardboard and particle board. Furthermore, it is suitable for flooring, vehicle bodies, furniture, handles, ladders, sporting goods, agricultural implements, veneer, plywood, core stock, matches, joinery, vats, toys, novelties, turnery and wood-wool. The wood is used for paper making. It is a source of fuel wood and charcoal. *Eucalyptustereticornis* is a major source of pollen and nectar, producing a caramel-flavored honey. The leaves are one of the sources of eucalypt oil. *Eucalyptus tereticornis* is used for reforestation, shelter-belts and shade. A decoction of the leaf serves to reduce fever and alleviates pulmonary problems (Duttet., al 2011).

The *Anthocephalusindicus* belongs to family Rubiaceae. It is large deciduous tree commonly known as Kadam with spreading branched rather shining leaves with prominent veins and small orange coloured flowers with globes head. Bark is grey, smooth in young trees and wood is yellowish white and soft. There is no separate heart wood. Specify gravity of wood is about 0.59. *Anthocephalusindicus*is cultivated in many parts of the India. It is the tree of moist warm regions frequenting moist types of deciduous and evergreen forests and occurring on alluvial ground along rivers and also on swampy ground. In its natural habitat the absolute maximum shade temperature varies from 35.6 ºC to 43.3 ºC, the absolute minimum from 3.0ºC to 15.6 ºC and the normal rainfall from 1500 mm to 5000 mm or more. Rate of growth in earlier years is very rapid. It has been observed that trees attained a girth of 061m and height pf 9.15 m in 4 years. the growth becomes slower after 6-87 years up to 20 years and then becomes very slow , the leaves fall in the hot season. It is very good species for making writing an printing paper. Wood from young tree is expected to yield still better paper due to the presence of more flexible fibers. Higher growth rate up to 6 to 8 year of age is the additional advantage. The flower are sacred to the Hindu and yield essential oil on distillation. The fruits are edible. The bark and leaves are used for medicinal purposes.

Proximate Analysis: Screened chips and pulp samples of *Eucalyptus tereticonis* and *Anthocephalusindicus* were converted to dust in a laboratory disintegrator. Dust passing through 40 mesh and retained over 60 mesh was taken for experimentation. TAPPI standard methods were adopted for proximate chemical analysis using extractive free dust. The conventional proximate chemical analysis can determined was Hot water Solubility (TAPPI 207-cm 22), 1 % Sodium hydroxide Solubility (TAPPI 212-cm 76), Alcohol benzene Solubility (TAPPI 204-cm 97), Klason lignin content(TAPPI 222 cm-88), Holocellulose (Wise et al 1946),Pentosan (TAPPI 223-OS – 78) (Anonymous 2002).

Pulping: *Eucalyptus tereticonis* and *Anthocephalusindicus* logs were debarked, chipped and chips were screened. Screened chips (15-30 x 10-20 x 2-3 mm) were taken for pulping experiments. Pulping experiments were carried out in a air pulping bath unit consisting of six bombs of 2.5 liter capacity using 10, 12, 14, 16 and 18 % active alkali as Na_2O at

25.0 % sulphidity level. Bath ratio 1 : 4 maximum temperature, 170ºC were kept constant in all the cases. Room temperature to 100ºC temperature was raised in 90 minutes followed by 10ºC rise in 15 minutes to 170ºC and kept at maximum temperature for 60 minutes. Pulping schedule corresponds to H-factor, 1110. Cooked material was washed with hot water, fiberized in laboratory disintegrater and screened over flat laboratory screen having 0.25 mm slots. Pulp yield and kappa number were determined in each case. Kappa Number of pulp is determined by TAPPI Standard method T 236-os-76. Kappa Number give an idea about residual lignin in pulp i.e degree of delignification / bleach ability(Khristovaet., al 2006, Dhoundiyal et., al 2019,Singh et., al 1987).

Beating, sheet making and physical strength properties of pulps : unbleached pulps were beaten in PFI mill at different revolutions. Hand sheets of 65±2 gm of each pulp were made on standard British sheet making machine, air dried, conditioned at 27±1 ºC and 65±2 % relative humidity and tested for various strength properties. Results were interpolated at freeness 250(ml) csf.

RESULTS AND DISCUSSION

Proximate Analysis of *Eucalyptus tereticonis* and *Anthocephalusindicus* :The potentiality of any raw material for pulp and paper manufacture was determined by proximate chemical analysis which provided essential information for preliminary characterization of the fiber resource. Ash content of *Eucalyptus tereticonis* and *Anthocephalusindicus* was 1.12 and 1.25 respective its reveal that inorganic content *Eucalyptus tereticonis*is slightly less in compare to *Anthocephalusindicus*. Cold water Solubility, Hot water Solubility, 1 % Sodium hydroxide Solubility and Alcohol benzene Solubility give idea about extractives present in wood. Extractive are the group of non structural wood constituents which usually represent the minor fraction. Lipophilic extractive can be classifies as terpenoids and steroids, waxes ,fats and phenols. Extractive have a negative effect on the pulp and paper making processes (Sefera at al 2004). Cold water Solubility, Hot water Solubility, 1 % Sodium hydroxide Solubility and Alcohol benzene Solubility of *Eucalyptus tereticonis* 5.67,8.53, 20.12 and 3.16 and for *Anthocephalusindicus*was 3.51,5.31 ,19.77 and 2.32 respectively. These solubility indicate that extractive content was much higher in *Eucalyptus tereticonis*which reveal that pulp colour was darker in *Eucalyptus tereticonis causing* pollution as effluents contain more colour. Much chemicals is needed for bleaching for *Eucalyptus tereticonis*pulp aslignin content is more i.e 28.20 as compare to 22.59 for *Anthocephalusindicus.* Cellulose is more in *Anthocephalusindicus*i.e 76.39 and 15.58 in compare to 66.50 and 12.03 for *Eucalyptus tereticonis*Halocellulosepercent indicate that chance of pulp yield is much more in *Anthocephalusindicus*

Table -1 Proximate Analysis of *Eucalyptus tereticonis* and *Anthocephalusindicus*

S.No	Particulars	Eucalyptus tereticonis	Anthocephalusindicus
1	Ash	1.12	1.25
2	Cold water Solubility	5.67	3.51
3	Hot water Solubility	8.53	5.31
4	1 % Sodium hydroxide Solubility	20.12	18.77
5	Alcohol benzene Solubility	3.16	2.32
6	Klason lignin content	28.20	22.59
7	Holocellulose	66.50	76.39
8	Pentosan	12.03	15.58

Effect of alkali chargeon pulp yield, kappa number and strength properties of unbleached pulps : It was observed that under the identical conditions of pulping for *Eucalyptus tereticonis*, pulp yield and kappa number decreased with the increase in alkali charge, as expected. Total pulp yield was 63.47, 52.52, 50.30, 46.57 and 46.40 % while screened pulp yield was 42.00, 44.70, 45.10, 46.40 and 46.00 % at 10, 12, 14, 16 and 18% alkali charge corresponding to 65.20, 56.34, 44.99, 32.69 and 26.46 kappa number,

respectively (Table 2). *Anthocephalusindicus*under the identical conditions of pulping, pulp yield and kappa number decreased with the increase in alkali charge, as expected. Total pulp yield was 70.94, 63.69, 53.62, 48.30 and 47.64 % while screened pulp yield was 55.58, 58.98, 49.49, 47.17 and 47.06 % at 10, 12, 14, 16 and 18% alkali charge corresponding to 60.04, 36.49, 24.76, 19.02 and 16.25 kappa number, respectively (Table 2). For both the pulps slightly lower screened pulp at 10 % alkali charge as compared to 12 % alkali charge is due to the higher amount of rejects. The pulping results reveal that pulping yield of *Anthocephalusindicus* is much more with low kappa number in same alkali charge. The low kappa number indicated that less bleaching chemicals is required for *Anthocephalusindicus*pulps means less pollution. The alkali charge of 14 % is optimum for*Anthocephalusindicus* and alkali charge of 18 % is optimum for *Eucalyptus tereticonis.*

Table -2 Pulping conditions, pulp yield and kappa number of *Eucalyptus tereticonis* and *Anthocephalusindicus*Kraft pulps

S.No	Particulars	Alkali charge, pulp yield and kappa number				
Eucalyptus tereticonis						
01	Active Alkali as Na_2O* , %	10.00	12.00	14.00	16.00	18.00
02	Total pulp yield*, %	63.47	52.52	50.30	46.57	46.40
03	Screened pulp yield*, %	42.00	44.70	45.10	46.40	46.00
04	Kappa Number	65.20	56.34	44.99	32.69	26.46
Anthocephalusindicus						
05	Active Alkali as Na_2O* , %	10.00	12.00	14.00	16.00	18.00
06	Total pulp yield*, %	70.69	63.69	53.62	48.30	47.64
07	Screened pulp yield*, %	55.58	58.98	49.49	47.17	47.06
08	Kappa Number	60.04	36.49	24.76	19.02	16.25

*percentage based on o.d raw material

Strength properties of *Eucalyptustereticonis* indicate that pulp produced using 10 % and 12 % active alkali was poor. Strength properties were improved with the increase of active alkali charge up to 18 % active alkali (Table -3), Burst index ($kPam^2/g$) 4.43,4.56 and 4.84 ; tensile index (Nm/g) 67.00,70.21 and 72.30; Tear index(mNm^2/g) 7.40,8.12 and 8.20 for 14,16 and 18 % active alkali respectively. The strength properties reveal that 18 % active alkali was optimum condition for pulping.

For *Anthocephalusindicus*, strength properties of the pulp produced using 10 % active alkali was lowest. Strength properties were improved with the increase of alkali charge up to 14 % active alkali followed by marginal drop in properties, in general or almost comparable (Table 03). Burst index ($kPam^2/g$) 5.86 ± 0.12; tensile index (Nm/g) 95.00 ± 0.50; tear index (mNm^2/g) 5.59 ± 0.05 at freeness 250(ml) csf for the pulp produced using 12 % and 14 % alkali in pulping suggested that though the pulp yield and kappa number were slightly higher for the pulp produced using 12 % alkali as compared to pulp produced using 14 % alkali during pulping, but the strength properties were more or less comparable and better than pulps produced using 10,16 and18 % active alkali under identical conditions of pulping. Therefore, 14 % alkali charged pulps were chosen as optimize parameter for *A.indicus*kraft pulps with an aim to achieve the pulps possessing optimum properties.

Table- 3: Physical strength properties of unbleached kraft pulps of *Eucalyptus tereticonis* and *Anthocephalusindicus*at freeness 250 (ml) csf

S.No	Active Alkali as Na_2O, %*	Apparent Density, g/cm^3	Tensile Index, Nm/g	Tear Index, mNm^2/g	Burst Index, $kPam^2/g$
Eucalyptus tereticonis					
1	10	0.67	56.32	4.26	3.15

2	12	0.69	66.36	5.60	3.96
3	14	0.70	67.00	7.40	4.43
4	16	0.71	70.21	8.12	4.56
5	18	0.72	72.30	8.20	4.84
Anthocephalusindicus					
6	10	0.75	80.5	5.18	4.41
7	12	0.79	94.5	5.54	5.54
8	14	0.81	95.5	5.64	6.00
9	16	0.80	94.0	5.60	5.50
10	18	0.79	87.5	5.38	5.00

*percentage based on o.d raw material

CONCLUSIONS

On the basis of analysis of data for pulp yield, holocellulose, kappa number klason ligninand strength properties etc, it was concluded that *Anthocephalusindicus* was a very potential alternative for Eucalyptus and other hard woods being used in pulp and paper industry.The studied *Eucalyptus tereticonis* and *Anthocephalusindicus* shows that both are suitable for paper making but *Anthocephalusindicus* required about 4 % less chemical during pulping. It required less bleaching chemicals because it have less lignin content so less kappa number in compared to *Eucalyptus tereticonis* for same alkali charge. The different strength properties reveal that *Anthocephalusindicus* is very good raw material for paper making. It was fast growing tree up to 9 years and not associated with any ecological problem just like with Eucalyptus. In a nut shell, *Anthocephalusindicus* is a very good alternative for Eucalyptus in economically and as well as environmentally point of view.

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