Preparation of Subabul (Leucaena Leucocephala) Seed Gum and It's Evaluation as Wet-End Additive in Paper Making

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ABSTRACT

Subabul seeds which are available in plenty hither to commercially unexploited, Process for the preparation of gum using rotary drum drier is developed. The yield of the gum was 30 percent and cost of the production is calculated as Rs. 4/kg taking into consideration the cost of the seed Rs. 1.00/kg at the production level of 300 tonnes/annum. Gum is evaluated for its effectiveness in improving the bonding properties of paper and performance compared with guar gum. It is found equally good Wet-end additive in paper making as guar gum.

Introduction :

Leucaena Leucocephala :— is a medium-sized leguminous tree of Mexican Origin and now introduced in most of the tropical countries for a variety of uses, such as forage, fuel, soil conservation and soil amelioration. It has now naturalised in Australia, Indonesia, Phillippines, Java, Hawaii, New Guinea, Fiji, India and many other tropical and subtropical countries. Seed production from *L leucocephala* is reported to be as high as 1307 kg/ha having 500 plant population per hectare[1]. Enormous amount of seed available from this source have not been commerially exploited till todate.

Leguminous seeds are known source of gums and mucilages which are used in large quantities in a variety of industries. Seed gums and mucilages are galactomannans and usually contain higher proportion of mannose than galactose. A notable exception is the polysaccharide isolated from alfalfa seed by alkaline extraction[2] where the galactose mannose ratio is determined as 2:1. *L leucocephala* seed is reported[3] to yield 25% gum and is composed of galactose, mannose in the molar ratio of 1 : 1.3. In our erarlier publications we have reported[4,5] the alkaline extraction of gum from the seed and found it suitable as wet—end additive in paper making. Besides the low yield of gum by this methed (20%), it also required alkali and its dilution in order to obtain the gum in the powder form using Kestener spray drier. The extraction procedure is further modified to make it commercially viable. In this process aqueous viscous mucilage (10.26 cps) is evaporated on rotary drum drier to obtain the gum in the from of dry thin film. It is scraped & powdered to 40 mesh (moisture 9—10%). It's effectiveness in improving the bonding properties of paper is investigated and performance compared with guar gum.

Experimental

Extraction of Gum from Seeds

Seed (1 kg, moisture content 13 6%) was boiled with water (4l) for 1hr and kept over night at room temperature. Milling of the seed is done using Bajaj grinder for 2—3 minutes and mucilaginous material was diluted further with water (7l). It is centrifused for 20 mts. at 2000 rpm and highly viscous mucilage (10 24 cps) was decanted out. The gum from the residual mass was extracted twice by addition of water (1.5l) each time and process of the isolation of mucilage is repeated. The whole viscous mass is subjected to rotary drum drier using steam pressure 20 lb/sq. inch. Thin dried layer is scraped and powdered to 40 mesh (moisture content 9—10%) for further use.

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Viscosity

Viscosity measurements are done using Brookfield viscometer.

Composition of the Gum

Gum (0.1 g) is hydrolysed with sulphuric acid (2N. 5 ml) on a steam bath for 20 hrs. It is cooled to room temperature, filtered and neutralized ($BaCo_3$). The constituent monosugars are reduced ($NaBH_4$) to alditols and converted to alditol acetate[6]. GIC of the resulting derivatives is carried out on CIC gas chromatograph fitted with a flame ionisation detector. Resolutions are performed on stainless steel column (5' x1/8") containing 3% of ECNSS–M on Gas chrom Q (100—120 mesh) at 170 200° (programmed 2°/min, nitrogen flow rate 60 ml/min) It showed the peaks corresponding to mannose, galactose, glucose and an unidentified peak.

Evaluation of Gum in Paper Making

Preparation of gum :

Guar gum and subabul gum were prepared by cooking them at 40°C for 2—3 minutes to a paste followed by dissolution in water to make 1% solution.

Pulp :

Semibleached Eucalyptus sulphate pulp beaten in PFI mill to 465 ml. freeness level as per ISO 5264 was taken for the studies.

Addition of gum to the pulp :

The quantity of gum & the stage at which it is added to the pulp, both are important to achieve the maxium benefit. For comparative studies both the gums (guar & subabul) were added in three concentrations i. e. 0 5, 1 0 and 1.5% on o d. pulp basis. Two points of addition of gums were studied.

(i) Addition of gum to the pulp during sizing — first rosin (1.5%) was added to the pulp then gums (0.5, 1.0 and 1.5%) and finally the alum, just sufficient to bring down the pH to 5.

(ii) Addition of gum to the pulp during beating— Required amount of gum (0.5, 1.0 & 1.5%) was mixed with pulp at 10% consistency followed by beating in PFI mill.

Preparation of hand sheets :

The hand sheets were prepared as per ISO — 5364 standard using white water recirculation system.

Testing of hand sheets :

The hand sheets were conditioned in controlled atmosphere (65±5% relative humidity and 27±1°C temperature) tested as per relevant ISO standards for strength properties.

Tear index	—	ISO 1974
Tensile index	—	ISO 1924
Burst index	—	ISO 2758
Folding endurance	—	ISO DIS 5626

Results and Discussion :

The *L. leucocephala* seed (K-8 and K-28 varieties) yielded 30 percent gum with different chemical composition as reported earlier[4,5]. The gum obtained from the seeds of K-8 and K-28 verieties have shown the presence of D-mannose, D-galactose and D-glucose in the molar ratio of 1:1.06:1.57 and 1:2.36:2.31 respectively. The cost of the production of gum is calculated as Rs 4.00/kg taking into consideration the cost of the seed Rs. 1.00/kg at the production level of 300 tonnes/annum. Total cost of the project was calculated as Rs 4.80 lakhs.

Viscosity of 1% solution of subabul and guar gum was found to be equal i. e. 1.28 mpa/sec at 30°C. Subabul gum gets dispersed properly in water preferably at lower temperature i.e. 40°C.

Addition of subabul and guar gum[8], both improved the strength properties of semibleached eucalyptus sulphate pulp. Table—I shows the relative effects of both the gums when they were added to the pulp during sizing, where as Table—II shows the same effect when the gums were added to the pulp during beating.

A more critical evaluation of the relative performance of the two gums in the improvement of pulp strength reveal the following facts.

(a) Gums added during sizing

	Guar gum	Subabul gum
(i) Amount of gum added (% on o.d. pulp basis)	1.0%	1.0%
(ii) Freeness (DECREASED by)	45ml	35ml
(iii) Tensile index (INCREASED by)	10%	10%
(iv) Burst index (INCREASED by)	14.5%	9.7%
(v) Double fold (IMPROVED by)	7.3%	12 0%

The improvement in tensile strength was same for both the gums where as burst strength increased more in case of guar gum. The improvement in fold was better in case of subabul gum, however dropped by about 7.6% in case of both the gums (Table—I.)

(b) Gums added during beating

	Guar gum	Subabul gum
(i) Amount of gum added (% on o.d. pulp basis)	1.0%	1.0%
(ii) Freeness (DECREASED by)	40ml	55ml
(iii) Tensile index (INCREASED by)	16%	12%
(iv) Burst index (INCREASED by)	9%	4%
(v) Double fold (IMPROVED by)	2%	23%

In this case improvement in the tensile & burst was relatively more for guar gum, however, fold recorded appreciably higher improvement in case of subabul gum. Unlike in the case when gums are added during sizing tear recorded about 8% increase in case of both the gums (Table-II).

TABLE—I

Effect of Gums (Added During Sizing) on Strength Characteristics of Semi—Bleached euc. Sulphate Pulp

	Properties	1.5 Rosin & 5%	Guar Gum			Subabul Gum		
		Alum Blank	0.5%	1 0%	1.5%	0.5%	1.0%	1.5%
1.	Freeness, CSF ml	425	395	380	385	400	390	380
2.	Tensile index (N/mg)	49.0	53 5	54.0	52.5	52.0	54.0	54.0
3.	Stretch %	4.3	4.5	4.7	4.4	4.7	4.7	4.9
4.	Burst index (KPa.m²/g)	3.10	3.30	3.55	3.50	3.10	3.40	3.40
5.	Tear index (mN. m²/g)	10.5	9.70	9.70	10.3	9.30	9.65	9.55
6.	Fold Kohler Molin (log)	1.65	1.76	1.77	1.70	1.72	1.85	1.76

TABLE—II

Effect of Gum (Added During Beating) on Strength Characteristics of euc. Semi—Bleached Sulphate pulp

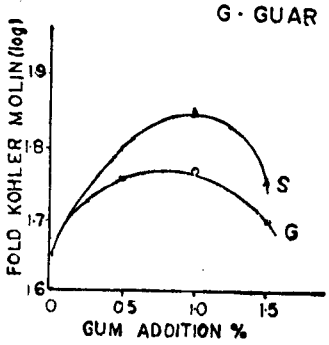
	properties	Blank	Guar Gum			Subabul Gum		
			0 5%	1.0%	1.5%	0 5%	1 0%	1.5%
1.	Freeness, CSF ml.	465	435	425	420	425	410	410
2.	Tensile index (N. m/g)	49.0	59 5	57.0	54 5	58.5	55.0	51.5
3.	Stretch %	5.0	4.6	4.5	4.3	3.8	3.9	4.3
4.	Burst index (KP am²/g)	3.40	3.65	3.70	3.55	3.45	3.55	3.40
5.	Tear index (mN. m²/g)	9.25	10.0	10.0	10.0	10.0	10.0	11.55
6.	Fold Kohler Molin (log)	1.86	1.93	1.90	1.90	1.97	2.29	2.26

Guar gum increase fibre bonding and improve sheet formation by inhibiting flocculation. It also helps in the retention of fillers. The most favourable effect on formation is obtained in the absence of alum. Normally these gums improve strength when added in the range of 0 1 to 1 percent in case of long fibred pulps. More than one percent gum produces no additonal improvement[9]. The point of saturation may be achieved even earlier in case of short fibred pulps. Marginal decrease in strength properties in case of 1.5% addition of gums indicates ineffectiveness of gums at that level. In case of tear index the improvement is more pronounced when the gums are added during beating, as compared to that obtained when gums are added during sizing. This could be explained due to the fact that sizing material being hydrophobic reduces the hydrophilic sites of cellulosic fibre resulting in relatively lesser fibre bonds. Generally the gums are added during beating for obtaining better effect. In case of stretch, it normally increased with tensile, however, reverse has been observed in case when the gums are added during beating. The reason could be attributed to the fact that stretch studies made on hand sheets are not very reliable due to variation in drying condition from day to day.

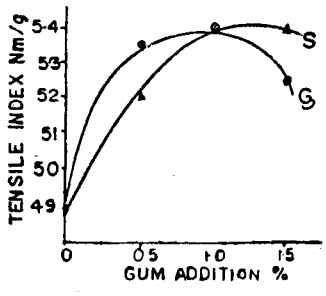
Addition of these gums decreases the freeness of the resultant pulp which means that there could be marginal saving in energy during beating.

Effectiveness of these gums on paper properties has been illustrated through figures 1-6, as well.

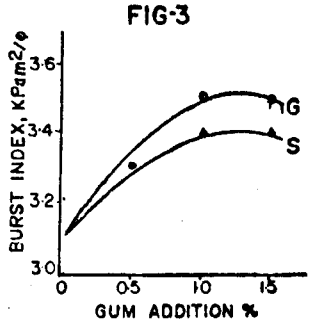
FIG·1 S· SU BABUL GUM G· GUAR GUM



FIG·2

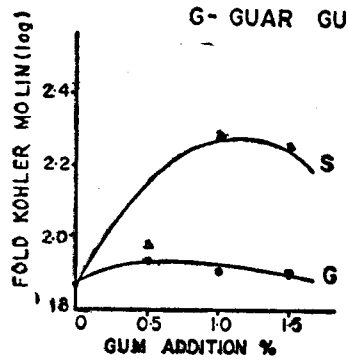


FIG·3

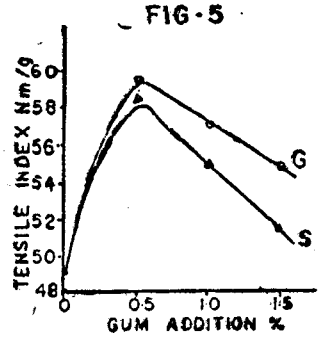


EFFECT OF GUAR & SU BABUL GUMS ON STRENGTH PROPERTIES WHEN ADDED DURING SIZING.

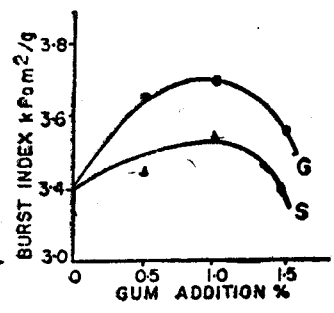
FIG·4 S· SU BABUL GUM G· GUAR GUM



FIG·5



FIG·6



EFFECT OF GUAR & SU BABUL GUMS ON STRENGTH PROPERTIES WHEN ADDED DURING BEATING.

CONCLUSIONS

1. Subabul seeds can be exploited for the production of gum in large scale. Viscosity of 1% gum is equivalent to guar gum at 30°C. The cost of the production of gum as calculated is Rs. 4.00/kg taking into account the cost of the seed Rs. 1.00/kg at the production level of 300 tonnes/annum Total cost of the project of above capacity was calculated as Rs. 4.80 lakhs.
2. Subabul gum could be used as wet end additive paper making.
3. It helps in improving the strength properties of paper.
4. It is comparable with guar gum in improving the strength properties of the final product.

References :

1. Relwani L.L., D.Y. Khandale and R.V. Nakal (1981) Proc. National Semin. on *Leucaena leucocephala*, Urlikanchan, June 26–27, pp. 211.
2. Hirst, E.L., J.K.N. Jones and W. O. Walder., J. Chem. Soc., 1443 (1947).
3. Morimoto, J.Y. I.C.J. Unrau and A.M. Unrau., Agric. Food. Chem., *10*, 134 (1962).
4. Soni, P.L., Attar Singh and A.K. Rai, Indian Forester, *110*, 931 (1984).
5. Soni, P.L., Attar Singh and N.P. Dobhal, ibid., *110*, 1030 (1984).
6. Jansson, P., L. Kenne, H. Liedgren, B Lindberg and J. Lonngren, Chem. Commun. Univ. Stockholm, No. 8 (1976) 5.
7. Chemicals and additives in paper making : IPPTA Vol. 19, No. 1, March 1982, p-40.
8. Wet-end operation with a furnish of 70% hardwood and 30% bamboo at SPB.
   IPPTA Vol. 19, No. 1 March 1982, p-63.
9. Pulp & Paper, Chemistry and Chemical Technology, Third ed. Vol. III by J. P. Casey, p. 1504. A Wiley & Sons Publication.