NS-AQ Pulping of Kash (*Saccharum spontaneum*)

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Pulping of Kash (Sccharum spontaneum) was done by neutral-sulfite (NS) and neutral-sulpite-anthraquinone (NS-AQ) processes with varying chemical charge and cooking time. The total pulp yield, screened pulp yield, reject, kappa number and viscosity were decreased with increasing chemical charge or cooking time. Addition of 0.1% AQ to the cooking liquor increased screened pulp yield by 0.7-1.1% and decreased reject by 0.2-0.3% without significant change in kappa number. The moderate beating of kash pulp leads to remarkable increase in drainage resistance. The O_2 prebleaching decreased kappa number by about 42% and increased brightness by 20.4% for NS and 18.8% for NS-AQ pulp with the sacrifice of 10% viscosity. Both pulps were bleached to above 80% brightness in ODEDP bleaching and about 75% brightness in OQPP bleaching. There was no significant difference in physical properties of NS and NS-AQ pulp in both bleaching processes. Slightly higher physical properties were observed in ODEDP bleaching.

Keyword : *Saccharum spontaneum*, Neutral-sulfite-enthraquinone, Pulp yield, Kappa number, Viscosity and Strength properties

INTRODUCTION

The basic raw materials (wood) of paper and paper products come from forests. But the random deforestation results in severe ecological problem. On the other hand, the forestland in Bangladesh is only 10.2%. So it is very difficult to supply conventional raw materials to pulp mills according to their demand. The shortfall of domestic wood fiber can be solved to some extent by using some potential nonwood fibers, i. e., annual plants, agricultural wastes and other non-conventional raw materials. In the present scenario, nonwood fiber pulp represents only 7% of the total world pulp production. China currently produces 77% of the world's nonwood pulp. The plant-based fibers will continue to be an important raw material source for papermaking in the countries like China, India, Bangladesh. In Bangladesh, the conventional raw materials for pulp and paper industries are bamboo, mixed hardwood, bagasse, Gewa wood, etc. Bagasse is a by-product of the sugar industry. The sugar industry uses it as a fuel for steam generation. Therefore, bagasse based paper industry in Bangladesh has shut down. On the other hand, Gewa wood is grown in Sundarban, Recently, United Nations declared Sundarban as a world heritage. So, Sundarban authority can't supply Gewa wood to the pulp and paper industries to meet their demand. Therefore, it is utmost need to find out alternative source of raw materials to survive our paper industry. One of such possible alternative raw materials is Saccharum spontaneum.. In Bangladesh, it is called "Kash" and in India "Kans grass". S. spontaneum is a perinial grass with slender culms, growing in stools or forming continuous canebrakes with most often aggressive rhizomatous tillering, distributed widely in the sub-tropical and tropical parts in Asia, Africa and ascending upto an altitude of 1,800 m (1). The forms of S. spontaneum show a wide range of variation in habitat and in the morphological character of stem, leaf and root. S. spontaneum is a coarse grass normally not relished by the cattle, and is generally used as fodder only during scarcity. A few investigators (2-5) showed the possibility to use it as a pulping raw material. Our previous investigation showed that Bangladeshi kash is morphologically and chemically suitable for pulping (6), it could be pulped easily to low kappa number and high yield in soda-AQ process and initial brightness was very high.

In this investigation, an effort was made on the pulping of kash by neutral-sulfite and neutral-sulfite-anthraquinone processes to get pulp of higher initial brightness and easier bleachability.

EXPERIMENTAL

Material

Kash was collected from the Jamuna Char and its leaves, roots were removed. It was cut into about 2-3 cm in length.

Pulping

Pulping was carried out in a 5 *l* capacity batch cylindrical reactor heated by means of electrical resistance and was rotated by a motor. The normal charge was 250 g of moisture free Kash.

The following parameters were maintained.

The chemical charge (Na_2SO_3/NaOH) was varied from 12 to 18% as NaOH on o.d. Kash.

The Na_2SO_4/NaOH ratio was 0.83

The cooking temperature was constant at 170°C

The cooking time was 60 and 120 min at the maximum temperature.

The liquor/material ratio was 6.

0.1% AQ was used in NS-AQ process.

After digestion, the pulp was washed until free from bleach liquor, disintegrated in a standard disintegrator and screened in Yasuda Flat Vibratory screener. The pulp yield was determined as percentage of oven-dry kash. The kappa number of the pulps was determined according to Tappi Test Methods (T 236 om-99).

Bleaching

Kash pulp obtained from NS and NS-AQ process at the condition of maximum selectivity (Yield-kappa ratio) was bleached in TCF and ECF bleaching sequences. The details of bleaching conditions are

Table 1 : Bleaching conditions of kash pulp

TCF	Temp °C	Time min	O_{press} Kg/cm²	NaOH % on pulp	H_2O_2 % on pulp	$MgSO_4$ % on pulp	DTPA % on pulp	ClO_2 % on pulp	pH
O	110	60	3	1.5	-	0.2	-	-	11
Q	80	60	-	-	-	-	0.1	-	4-4.5
P	70	60	-	1.0	2.0	-	0.1	-	11
ECF									
O	110	60	3	1.5	-	0.2	-	-	11
D	70	60	-	-	-	-	-	50*	2-2.5
E	70	60	-	-	-	-	-	-	11.5
D	70	60	-	-	-	-	-	50*	3.5-4.5

* 50% of total chlorine demand

Table 2 : Effect of chemical charge and cooking time on the NS pulping of kash

Chemical charge, % as NaOH	Cooking time, min	Pulp yield, %			Kappa number	Viscosity mPa.s
		Screened	Reject	Total		
12	60	44.6	10.0	54.6	23.2	18.7
14	60	43.3	6.1	49.4	21.0	18.0
16	60	42.9	4.5	47.4	19.4	17.6
18	60	42.0	4.1	46.1	18.6	17.1
12	120	44.1	3.2	47.3	20.5	17.4
14	120	42.3	2.3	44.6	18.7	16.8
16	120	41.1	2.0	43.1	17.4	16.6
18	120	40.4	1.7	42.1	16.8	16.1

given in Table 1. The kappa factor 0.22 was used for ECF bleaching.

Evaluation of pulps

Bleached and unbleached kash pulps obtained by NS and NS-AQ processes were beaten in a PFI mill to different revolutions. The handsheets of about 60g/ m^2 were made in a Rapid Kothen Sheet Making Machine according to German Standard Methods DIN 106. The sheets were tested for tensile (T 494 om-01), burst (T 403 om-2) and tear strength (T 414 om - 98) according to TAPPI Standard Methods.

RESULTS AND DISCUSSION

Table 2 shows the effect of chemical charge and cooking time on the neutral sulfite (NS) pulping of kash (S. spontaneum). It is clearly seen that the total pulp yield, screened pulp yield, reject, kappa number and viscosity decreased with chemical charge regardless of cooking time. The screen reject was higher (4-10%) in 60 min of cooking, it decreased when cooking time was increased to 120 min. This may be attributed to penetration of cooking chemicals. The screened reject decreased to 2.0% from 4.5% with increasing cooking time from 60 to 120 min at 16% chemical charge. Addition of 0.1% AQ to the cooking liquor increased screened pulp yield by 0.7-1.1% and decreased reject by 0.2-0.3% without any significant change in kappa number (Table 3). The marginal loss of viscosity was observed when AQ was added in the cooking liquor. This may be explained by the retention of hemicellulose in NS-AQ pulp of kash. Fig.1 shows the selectivity (yield-kappa relationship) of NS and NS-AQ pulping of kash. At any kappa number, pulp yield was higher in NS-AQ process. At kappa number 18.5, NS process gave yield of 44.4%, which was 0.6% lower than NS-AQ pulping. Kash shows similar pulp yield and lower kappa number than that of dhaincha (7). It is observed from our previous investigation that soda-AQ process produced better pulp yield and kappa number than the present neutral sulfite process for kash pulping (6). In the previous experiment, we used kash after extracting sugar for cattle feed. One NGO named Jamun's char in Bagladesh used kash for extracting sugar for cattle feed. After sugar extraction,

Table 3 : Effect of chemical charge on the NS-AQ pulping of kash

Chemical charge, % as NaOH	AQ, %	Pulp yield, %			Kappa number	Viscosity mPa.s
		Screened	Reject	Total		
12	0.1	44.8	3.0	47.8	20.6	17.0
14	0.1	43.0	2.0	45.0	18.5	16.7
16	0.1	42.2	1.8	44.0	17.2	16.4
18	0.1	41.3	1.5	42.8	16.9	16.0

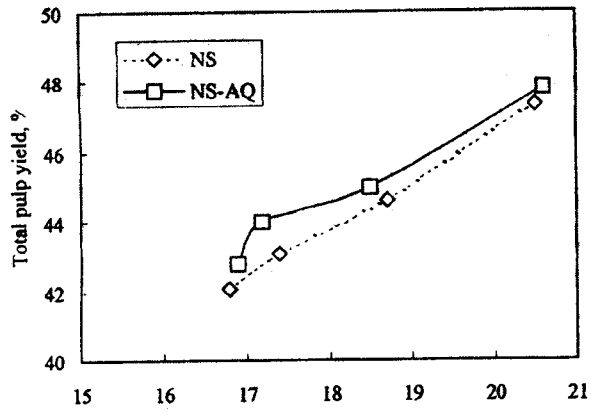

Figure 1 : Selectivity of NS-AQ pulping of kash

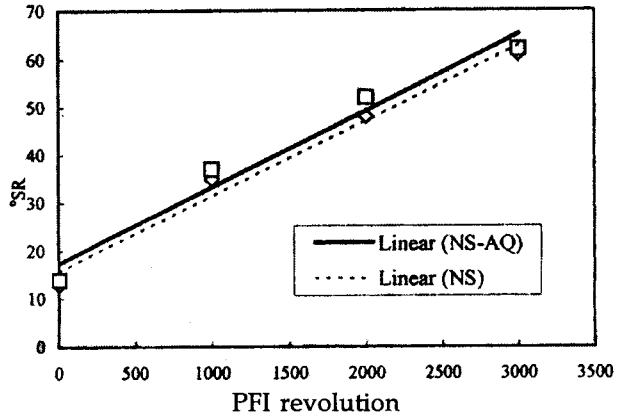

Figure 2 : Development of SR value PFI revolution.

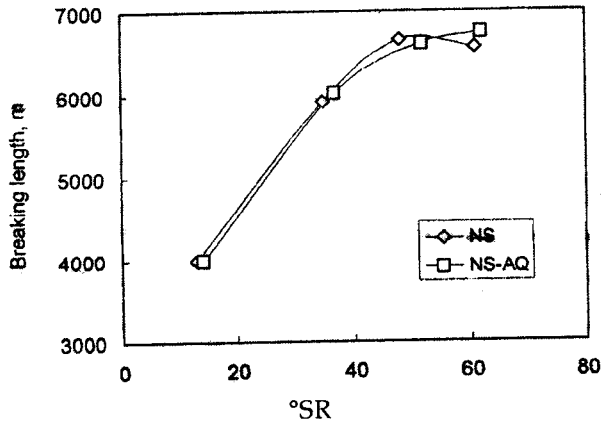

Figure 3 : Development of breaking length of NS and NS-AQ kash with beating

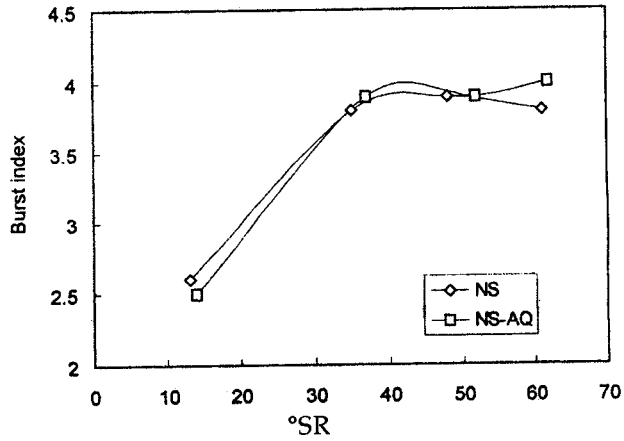

Figure 4 : Development of burst index of NS and NS-AQ kash with beating

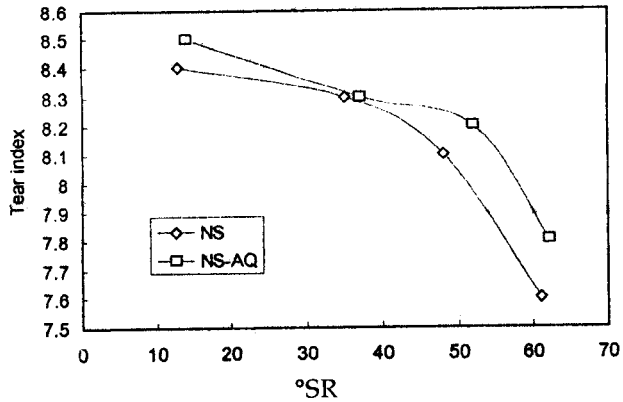

Figure 5 : Development of tear index of NS and NS-AQ kash with beating

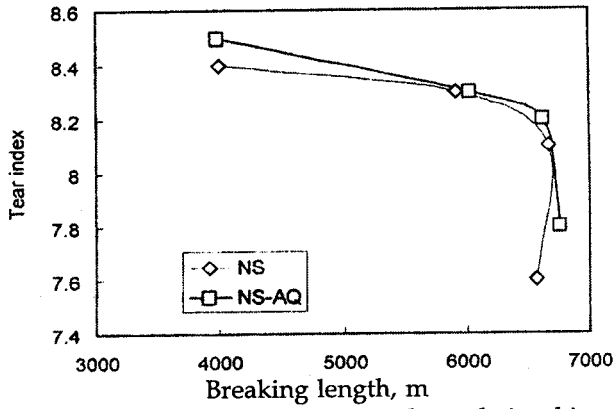

Figure 6 : Breaking length tear index, relationship of NS and NS-AQ pulp.

they discarded the kash, which was brighter and cleaner than the presently used kash. This is the main reason of inferior results in the present investigation (NS and NS-AQ process).

It can be seen from Fig. 2 that moderate beating of kash pulp leads to remarkable increase in drainage resistance. Only 2000 revolution increased °SR value to 48-52 Higher hemicellulose in kash pulp causes easier beatability. The kash pulp, therefore, hydrated more easily and responded more quickly on beating. NS-AQ pulp showed an easier beatability than NS pulp (Fig. 2). It is clearly seen from Figures 3-4 that the breaking length and burst index of kash pulp were improved with minimal amount of energy on beating. NS-AQ and NS pulp showed an almost similar breaking length. The maximum breaking length (6671m) in NS pulp was obtained at 48°SR value, while NS-AQ pulp exhibited maximum breaking length 6622 m at 52°SR value. The burst index of kash pulp obtained in NS and NS-AQ processes was almost equal and overlaps each other. The tear index of kash pulp decreased slightly with beating degree (Figure 5). The

Table 4 : Oxygen delignification of NS and NS-AQ kash pulp

	NS		NS-AQ	
	Unbleached pulp	O_2-prebleaching	Unbleached pulp	O_2-prebleaching
Pulp yield, %	41.1	40.3	42.2	41.4
Kappa number	17.4	10.0	17.2	9.9
Viscosity, mPa.s	16.6	14.8	16.4	14.7
Brightness, %	28.9	49.3	28.7	47.5

Table 5 : OQPP and ODEDP bleaching of NS and NS-AQ kash pulp

	NS		NS-AQ	
	OQPP	ODEDP	OQPP	ODEDP
°SR	43	42	44	42
Breaking length, m	4418	4481	5121	5247
Burst index, kPa.m²/g	2.8	3.2	2.9	3.2
Tear index, mNm²/g	6.9	7.8	6.7	7.0
Brightness, %	75.8	83.5	75.2	84.2

strength properties of kash pulp were similar to cotton stalks pulp (8). From the papermaker point of views, tear- tensile relationship is one of the most important properties of pulp. Figure 6 shows almost similar tensile-tear relationship of NS and NS-AQ pulp. At the breaking length of 4000 m, NS-AQ pulp showed a slightly higher tear index, but the tear index of NS-AQ and NS become similar with increasing breaking length.

After O_2 stage, the kappa number, viscosity and brightness were determined and shown in Table 4. The O_2 stage decreased kappa number by about 42% and increased brightness by 20.4% for NS and 18.8% for NS-AQ pulp with sacrifice of 10% viscosity.

Oxygen delignified NS and NS-AQ pulp was bleached by OQPP and ODEDP bleaching sequences and data are shown in Table 5. Both pulps were bleached to above 80% brightness in ODEDP bleaching and about 75% brightness in OQPP bleaching. The brightness achieved was higher than that reported for oxygen-delignified peroxide bleached soda-AQ reed pulp (75% ISO brightness) (9). There was no significant difference in physical properties of NS and NS-AQ pulp in both bleaching processes. The breaking length and tear index of NS pulps were 4418 m & 6.9 mN.m²/g for OQPP and 4481 m & 7.8 mN.m²/g for ODEDP, respectively while these properties of NS-AQ pulp were 5121 m & 6.7 mN.m²/g for OQPP and 5247 m & 7.0 mN.m²/g respectively at 42-44°SR Thus, slightly higher physical properties were observed in ODEDP bleaching. The kash pulp may be used in writing grade paper.

CONCLUSIONS

The total pulp yield, screened pulp yield, reject, kappa number and viscosity of kash pulp decreased with chemical charge or cooking time. Addition of AQ improved pulp yield. The oxygen delignification of kash pulp reduced kappa number by 42% and increased brightness by 18-20%. The QOPP and ODEDP bleaching produced pulp of 75 and 84% brightness, respectively.

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