

'Newsprint Grade Pulp from Whole Mesta Plant of Hibiscus Sabdariffa Variety'

Part-I. Agricultural Aspect and Preliminary Screening

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Newsprint is an essential commodity for our country. With rising literacy the consumption of Newsprint will increase and it is expected to be double within next decade. Unlike, U.S.S.R. or North America, India does not have huge forest resources to cope with the requirement of 600 million people. We must search to find new paper making fibre plant or tree which can be grown at any place in good yield and in short time. Unless we achieve this, we have to face large import of Newsprint, price of Newspaper will rise sharply and some Newspaper and magazines may even have to cease daily publication

Indian Council of Agriculture Research (I.C.A.R.), an autonomous Council under Central Ministry Of Agriculture, who made very useful contributions towards the growth of various agricultural products in our country, specially food & textile fibre, has recently turned its attention to explore new paper making raw materials, specially for Newsprint. This subject was discussed in jute Workshop meeting at Agricultural University Sabur (Bihar), during 1982 where Mesta plant which is grown for fibre extraction was suggested to be evaluated for Newsprint pulp by Dr. C. Kempanna, ADG (Cash Crop) of ICAR. Though a preliminary trial on making Newsprint from Mesta plant was carried out by Sun Paper Mill, Near Madras¹ but it was felt that much more research is needed to select the plant specie which may be most suitable and most economic for pulping purpose.

Therefore an all India Co-ordinate Project Scheme was taken up by I.C.A.R. to carry out extensive research for improving yield and quality of both varieties of Mesta, Hibiscus Cannabinus and Sabdariffa, at the experimental station at Amadalavalasa, A. P. and at Jute Agriculture Research Institute, Barackpore, W.B.

The idea received strong support from Research Institute of Newspaper Development (RIND), Madras and as a result during 1983, Faizabad Jute Workshop meeting, a Working Group was formed who was vested with the assignment to evaluate agricultural viability and technoeconomical feasibility for utilisation of whole Mesta Plant for manufacturing Newsprint in India. Jute Technology Research laboratories Calcutta which is under ICAR and Central Pulp and Paper Research Institute, Dehra Dun, were selected members of Working Group to carry out technological research on this new venture. The former laboratory (JTRL) will carry out preliminary screening of various Mesta plants grown at the agricultural research centre and the later laboratory (CPPRI) will carry out scale up pulping of a selected variety of Mesta at the pilot plant facilities available there specially thermo-mechanical pulping.

In this presentation Part I, our research results on few varieties of Hibiscus Sabdariffa, which is easy to grow with minimum care even under low rainfall conditions have been reported. The pilot plant pulping experiments of the selected variety plant will be presented in Part II by CPPRI.

Methods and Materials.

Raw Materials

The experimental plant, Hibiscus Sabdariffa variety was grown around Agricultural Research Station, Amadalavalasa, A.P., under Supervision of Mr. R.V. Appa Rao, Plant Breeder. The plant was harvested after 50% flowering stage when yield reached maximum (130-140 days after sowing) After harvesting, the plant was left at the field for few days to shed leaves.

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The plant was sun dried and then tied into convenient bundles for transporting. The Agricultural data on the plant is presented in Table-1.

TABLE - I
AGRICULTURAL DATA ON MESTA PLANT
HIBISCUS SABDARIFFA

Source	Andhra Pradesh, Sriakulam Dist.
Sowing period	May
Seed requirement	12.5 Kg/HA
Fertiliser dose	20 Kg. Nitrogen/HA
Harvesting Period (50% flowering stage, 130-140 days)	October end or early November
pH of the soil	5.5-6.0
Soil type	Sandy, Clay loam
Yield of Whole Plant (Green)	25 ton/HA
Yield of dry plant (12% moisture)	6 ton/HA
(Photoperiodism)	Day length above 12 hrs.

2. Cutting and Storage

The air dry plant was cut into 1-2 inch size manually by hammer and knife. The chips were stored in a polythene bag. Alternatively it may be stored in heap form in dry space but under shade. For chemical analysis the chips were disintegrated to 30-40 mesh size. Analysis of fibre and stick position was carried out by removing the fibre part from dried plant by hand. The fibre and stick separately weighed to find their ratio in the plant.

3. Preliminary Screening for Pulping in beach scale

For preliminary pulping study 1 Kg. of the plant in 1 inch chip size was used. Cold soda treated 5-10% (overnight) or water digested chips (140°C, 5 min) was passed through laboratory 12 inch Sprout Waldron disc Refiner at three passes. This was followed by a short beating in a valley beater to freeness of 40 SR Hand Sheet of 16×12 size, 50-60 GSM was prepared at the sheet lifting Vat using screen of 60 mesh. Sheets were transferred to aluminium plates and air dried. Tensile strength and Fold endurance of the sheet was measured by standard German instruments. Chemical analysis of chips were carried by TAPPI standard procedure

Bleaching of pulp was carried out by Calcium Hypo solution at pH 10-11. For peroxide bleaching, procedure described by C. I. P. Research, Canada² was followed.

RESULTS AND DISCUSSION

There are two species of Mesta, *Hibiscus Cannabinus* and *Hibiscus Sabdariffa*. The former species yields good quality of fibre and is a close substitute of Jute. Fibre from other variety is course and harsh and has not much textile use. Therefore for paper making we have paid more attention to this variety of mesta, namely *Hibiscus Sabdariffa*. This plant can be widely grown in two harvest seasons, August and November with minimum care, needs less rainfall and can withstand drought for prolonged period. *Cannabinus* variety needs more rainfall and can not withstand drought, also it is more susceptible to pests, bugs and shootborer as compared to *Sabdariffa* variety. In U.S.A., under the programme of search for new paper fibre³ Kenaf of *Cannabinus* variety was identified to be suitable for soft wood but the *Sabdariffa* variety was reported unsuitable for paper making, specially for Newsprint. So all their research effort was devoted to *Cannabinus* variety. But in India, due to high market price of fibre from *Cannabinus* plant, such plant, may be uneconomic for paper making. So we concentrated our research more on *Sabdariffa* mesta and our finding is that the plant can be grown in higher yield than *Cannabinus*, at a low cost and the quality of pulp is as good as *Cannabinus* mesta at a certain stage of growth. The growth of the *Hibiscus Sabdariffa* is slower than *Cannabinus* mesta initially, but after 120 days, the growth is very fast and at 50% flowering stage, the yield of plant was higher than *Cannabinus*. The cost of production of this plant which includes land, fertiliser and harvesting has been estimated to be Rs. 250/ton, air dry basis (12% moisture). However, because the plant is light, density nearly half of bamboo, the transportation cost will be relatively high specially for long distance hauling. But if a paper mill is situated at the heart of mesta growing centre, where hauling distance does not exceed 100 Km, the price of the plant at the mill gate should not be above Rs. 500-600 ton. Considering the yield 6 ton/HA, for a medium scale Newsprint mill for 200 tons daily consumption, land area of 1200 HA (which is equivalent to 120 Sq. Km.

area) will be required to grow the required quantity of plants, which would be obtained in two harvest, August and November. Because for good growth, day light of 12 hours is necessary, the plant may not be grown economically during winter months, specially at the latitudes above 20N, where day light drops below 11 hours. Detailed information of Agricultural data has been presented in Table I.

CUTTING AND STORAGE

Any rotary cutter will chop the plant easily where-in the stick and fibre separate out. The whole thing becomes very bulky and becomes unmanageable at the refiner. The fibres get entangled inside disc causing jamming. The best result was obtained by cutting the dry plant in 1 inch size (2.5-3.0 Cm) in which stick and fibre were in³ intact form. Refining becomes easy and sheet properties were better. At the laboratory the plant was cut manually, but we have to find a suitable cutter, guillotine type. JTRL is collaborating with Eastern Paper Mill at Calcutta and Manco Engineering at Haryana to develop an efficient cutter and we hope such cutter will be available before the next year's harvest so that we can have a trial at the field. In U.S.A., it was reported that in their trial at International Paper Company, cubes were made with the help of special machine from chopped kenaf. But this procedure may not be economical for us, we rather have a suitable chipper, not a chopper. Our observation was that green plant can not be smoothly cut, It has to be dried below 20% moisture for smooth cutting.

The chips could be stored in a polythene bag or in heap form under shade. There has been no change in pulping behaviour or sheet properties after 10 months of storage. Results of out door storage are not available at present but experiments are in progress which will be reported later. It was observed that on storage, Cannabis plant develop some fungus and powder deposit on the surface. But no such behaviour was noticed with Sabdariffa plant which indicates that this variety has better keeping quality than Cannabis variety.

PHYSICAL DATA AND CHEMICAL COMPOSITION

The plant consisted of both long and short fibre in the ratio of 1:2. The long fibre was found to have ultimate cell length 2.3 mm. and short fibre 0.3-0.4mm.

Such combination seems to be ideal for newsprint pulp requirement, the short fibres which is 65-75% of the plant will give high opacity and good printability and long fibre, 30-35% will contribute for tensile and tear. Therefore, mesta is a raw material of type two in one, so a second raw material having long fibre may not be necessary.

The physical data and chemical composition of the plant and plant components have been presented in Table-II. The chip density increased slightly on

TABLE-II
PHYSICAL AND CHEMICAL DATA ON
SABDARIFFA MESTA

Maturity Period, Days	90	120	140	180*
			(50% flowering)	
% α -Cellulose	48.2	48.0	47.9	48.2
% Lignin	18.1	18.3	18.2	18.2
Chip density Gm/CC	0.26	0.26	0.28	0.30
Hot Water Solubility (140°C, 5 min).	12.0%	12.1%	10.0%	9.5%
10% Alkali Solubility	18.0%	17.5%	17.5%	17.0
α -Cellulose on Fibre part	61.0%	60.5%	60.2%	60.5%
Stick part	39.8%	40.0%	40.0%	40.1%
Ash	4.8%	5.0%	5.5%	6.0%
Fibre length				
Bast fibre	—	—	2-3mm.	(35%)
Stick fibre	—	—	0.3-0.4mm.	(55%)

*Source, MAHYCO, Jalana. Maharashtra. (Seed Plant)

maturity but still it was low, nearly half of bamboo. Suitability of such material for continuous thermo-mechanical pulping is being evaluated at the pilot plant of Central Pulp and Paper Institute, DehraDun. But one favourable factor for the plant is low lignin content, 18% average, which is considerably lower than soft wood or bamboo. Low lignin in the mechanical pulp makes it bleachable with moderate amount of chlorine. At the same time α -Cellulose content of Mesta being higher than bamboo or bagasse, it should give higher yield and better quality of pulp.

PRELIMINARY SCREENING OF THE PLANT FOR MECHANICAL PULPING

Four varieties of Sabdariffa and two varieties of Cannabis plants were screened for pulping. The

results have been presented in table III. The results indicated following facts:

i) Good sheet properties were obtained from all plants by cold caustic pulping.

ii) Water digestion alone, without any chemical yielded bleachable pulp, having satisfactory sheet properties from Sabdariffa plant harvested at 50% flowering stage, the sheet properties were comparable to Cannabis plant. The sheet strength of 90 and 120 days maturity Sabdariffa plant was inferior

to Cannabis plant. Above results indicate that the particular Sabdariffa plant may respond well to thermo-mechanical pulping.

iii) Yield of bleached pulp to 60 brightness was above 80% for water digestion pulp and 74% for cold caustic pulp.

iv) Sheet properties of Sabdariffa reed plant were excellent, best of all the plants tested.

Tensile and fold properties of cold caustic pulp from Sabdariffa plant (E in Table III) are comparable

TABLE III
PRELIMINARY PULPING RESULTS OF MESTA PLANT

Plant type	Days of Maturity	Pulp yield %	Tensile Strength (BLM)		Fold No.		Brightness	
			Un-bleached	Bleached	Un-bleached	Bleached	Un-ble.	Bleached
Sabdariffa (A)	90	Water digestion	87.0	81.0	1300, 2-3	1800, 8-10	40-42	55-60
		Cold Alkali	86.5	74.5	2200, 8-10	2450, 15-20	38-39	55-60
Cannabis (B)	90	Water digestion	88.0	81.0	1810, 3-4	2700, 8-12	40-42	55-60
		Cold Alkali	86.0	74.5	2500, 8-10	2800, 15-20	38-39	55-60
Sabdariffa (C)	120	Water digestion	88.5	81.0	1450, 2-3	2000, 8-10	40-42	55-8)
		Cold Alkali	80.0	74.0	2350, 3-4	2600, 8-12	38-39	55-60
Cannabis (D)	120	Water digestion	88.8	81.2	1820, 2-4	2700, 8-12	40-42	55-50
		Cold Alkali	81.0	74.8	2480, 8-10	2900, 18-20	38-39	55-60
Sabdariffa (E) (50% flowering)	140-150	Water digestion	90.0	82.5	1800, 3-4	2680, 8-12	40-42	55-60
		Cold Alkali	82.0	75.0	2500, 8-12	2980, 18-22	38-39	55-60
*Sabdariffa (F) (Seed Plant)	180-200	Water digestion	91.0	83.0	2200, 5-10	3400, 20-22	40-42	55-60
		Cold Alkali	82.0	75.5	3000, 20-33	4500, 40-45	38-39	55-60
Statesman News paper (25/6/83) Calcutta	—	—	—	—	—	3000, 15-20	—	60

*Source MAHYCO, Jalana, Maharashtra

to commercial News paper. Such pulp may not need blending with any chemical pulp. However, Tensile and fold of Water digested pulp from same Plant is little short of commercial News paper and such pulp will need blending with 10-20% chemical pulp. Super quality newsprint may be obtained from seed plant but because harvesting time is too long, 180-200 days, farmers may not like to grow the plant. They may need the land to grow winter crops or wheat. Also what to do with the huge amount of seeds obtained after harvesting such plant? If the seeds could find commercial uses for oil, protein, active chemicals, etc., then raising seed plant for high grade Newsprint may become viable.

During small scale pulping experiments,

During small scale pulping experiments, it was observed that green plants were easier to pulp and bleach. After few months storage presoaking in water for atleast 24 hours was found necessary before water digestion otherwise the digested chips won't pass through refiner.

Regarding bleaching it was observed that both types of Mesta mechanical pulp could be bleached easily in short time with calcium hypochlorite adjusted to pH 10-11 by adding NaOH at 50-60 C. But with chlorine water treatment the bleaching was slow and the pulp became resistant to further bleaching

even by alkaline hypochlorite. Bleaching by hydrogen peroxide went smoothly and brightness of 60 was obtained by 3% H₂O₂ in one step. The sheet properties were similar to hypo bleached sheets. For hypo bleaching 6-8% chlorine was used in two step process.

CONCLUSION AND RECOMMENDATIONS

A particular variety of Sabdariffa plant has been identified and characterised which gave higher plant yield than Cannabinus variety and have pulp properties comparable to latter plant. Such Sabdariffa plant can be grown abundantly in many States of India even where rainfall is less. From the preliminary pulping results indicate that if properly developed, this raw material will not only solve the chronic shortage of newsprint pulp in India but also will produce quality newsprint of foreign standard. It is recommended that this plant should be immediately evaluated for scale up pulping experiments at the facilities available at CPPRI, Dehra Dun, who is also the member of our Working Group. This should be followed by few runnability tests at the paper making machine in order to assess the techno-economical feasibility of using such plant for Newsprint manufacture in India. The plant should be particularly evaluated for thermo-mechanical pulping.

Following are the recommendations for future development of Mesta Newsprint.

- a) To carry out further research in agricultural side specially on hybrid variety of mesta in order to increase the yield. Cannabinus plant having higher yield 8-9 tons/acre and having lower lignin content has been reported.^{3,5} Can we achieve this for Sabdariffa plant?
- b) Pilot plant pulping and Runnability tests should be carried out with the plant stacked out side for various length of time, 1-12 months.
- c) Together with runnability tests printability tests of

the rolls should be carried out at standard Newsprint machine.

- d) A cutter to give uniform chips size of mesta plant should be developed immediately.
- e) A large scale trial should be arranged in near future at some Newsprint mill for which few hundred tons of the plant has to be procured.

After all the work outlined above is completed, we will be then in a position to evaluate agro-technoeconomical feasibility of the raw material for manufacturing Newsprint in India.

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