Chemical and Mechanical Analysis of Indian Cotton Linters

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Cotton is one of the major crops of our country occupying the 4th position in the world[1]. After the removal of the textile fibre the ginned cotton-seed is once again the source of many valuable by-products viz., linters, cotton seed oil, cotton seed cake, hulls, etc. But we are yet to exploit our linters potential fully. Table 1 indicating the total production of cottonseed, total installed capacity and the total linter production highlights the above statement.

Among the by-products the cotton seed oil and cotton linters are the most important ones. Cotton linters are those short fibres which are left on the seed after the removal of long fibres for textile purpose. As the cotton linters are source of purest cellulose in an uncombined form, they constitute a very important industrial raw material far various cellulose based chemical industries. The operation of removal of linters from the cotton seed is known as "Delinting" and is carried out through delinting machines. The delinting units are invaribly attached to the cotton-seed crushing units. In our country unfortunately, the cotton seed crushing units are in a disorganised state. They are yet to come out of the state. where the cotton linters are considered as an unwelcome by-product rather than a very important renewable source of pure cellulose. Under such conditions, it is not surprising that the delinting operations are often attended with carelessness and neglect. The consequences of the above are naturally reflected on the quality of cotton linters. The linters get contaminated with cotton stalks, portions of cotton boll, sand and host of other impurities. As a result, the quality of our linters has been a major concern to the consumers especially so to the manufacturers of cellulose derivatires and paper, where the impurities present in the initial raw material shows up in the final product.

In this paper, we are presenting the results of the mechanical and the chemical analysis of 22 cotton linter samples collected from various delinting units from different parts of the country, to provide an overall view of the quality status of Indian Cotton Linters.

Materials and Methods

In all, 22 cotton linter samples belonging to 1980-81 season were collected from different regions of our country. The samples consisted of various grades of linters v.z. First cut, Second cut and Mill-run linters. All the samples of linters were subjected to the following analysis :

a) **Mechanical Analysis**

The Mechanical analysis was carried out to quantify the trash and to get an idea about the amount of very short fibres present in the sample. This was carried out through Shirley Trash Analyser. 100 g sample of linters was passed through the Shirley Analyser and the clean linters separated from the trash, was retained in the lint delivery box. The trash along with the accompanying linters was again passed through the Analyser. The above operation was repeated three times which was found to be sufficient for optimum separation of fibres from the trash. At the end of the operation the trash collected in the trash pan and the clean fibres collected in tbe delivery box were weighed separately. The difference between initial weight of the sample and the combined weight of the trash and the clean fibres is termed as invisible loss which is mostly made up of very short fibres.

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TABLE I—Details of the Cotton Linter Production and its Exploitation in India for the year 1980—81

Total Production of Cotton Seed	Cotton Linters Recoverable @ 6% on Seed Weight	Total Installed capacity in M.J. seed/300 days	Total linters produced in M.J.
2,601,000 M.T.	156, 060 M.T.	1,054,150 M.T. Seed/ 300 days	30,000 M.T.

Hand Book of Cotton—seed Crushing Industry in India, April, 1982.

Chemical Analysis

The Chemical analysis of both raw as well as the purified linters was carried out in order to get an idea about the general chemical purity of the samples.

b) The chemical cotton was obtained from the raw linters samples as follows :

50 g of accurately weighed sample of raw linters without giving any mechanical cleaning was subjected to an alkali boiling treatment of 4% NaOH at 15 lb/inch^2 for 4 hours with Material to Liquor ratio of 1 : 20. The alkali boiled sample was washed with cold water and soured with 1% acetic acid for 1/2 hour and washed with water. The bleaching of the above sample with sodium hypochlorite was carried out with 2 g/litre of the available chlorine for 2 hours at 35°C with 1:20 as M:L at pH 10. After the completion of the bleaching, the sample was washed thoroughly with cold water and given an antichlor treatment with 1% Sodium metabisulphite for 1/2 hour and washed with water. The sample was air dried and weighed accurately to obtain the percentage of chemical cotton.

c) The alpha cellulose content of the purified sample was carried out as per the ISI Method[3].

d) The cellulose yield of all the samples were carried out as per the standard AOCS Method.

e) The ash content of the raw as well as the purified linter samples was carried out as per the standard method[2].

f) The whiteness Index of the bleached linter samples was measured employing Datacolor—HP—85.

Results and Discussion :

The results of the mechanical analysis of the cotton linter samples are presented in Table II. As can be seen from the table, the "trash" which comprises of non-cellulosic materials (taken together) shows a wide variation. The trash content varies from as low as 10% to as high as 28% which must be considered rather high. This arises mostly due to the inadequate cleaning of cotton seeds prior to delinting in the delinting units.

This invisible loss represents the very short fibres lost in the pneumatic suction filter system and are related to the loss of fibres in the numerous washings involved in the production of chemieal cotton. The data pertaining to the invisible loss shows a wide variation. The loss ranges between as low as 2% to as high as 28%. In the case of sample No. 2 the invisible loss is as high as 56%. Such a wide variation in this parameter is alarming and lends credence to the common complaint of the linter consumers about the length variability of Indian linters which in turn leads to the poor yield of the end product.

The samples under investigation comprise of various grades of linters viz, 1st cut, 2nd cut and Mill run, and this could have led to the observed variation in the percentage invisible loss. Hence a set of 18 samples of 2nd cut linters collected from various delinting units were subjected to Shirley Analysis and the invisible loss percentage is presented in table II. The invisible loss in this case also varies between 11% to as high as 28% and in one case as high as 56%. The above observed variation is clearly the result of improper delinting practices followed in the various delinting units.

The chemical analysis of raw as well as purified linters in terms of their ash content, ether soluble con-

TABLE II—Invisible Loss in Second Cut Linters

S. No.	Invisible Loss
1	26
2	56
3	16
4	22
5	28
6	16
7	20
8	22
9	16
10	15
11	22
12	12
13	20
14	16
15	17
16	19
17	11
18	24

tent, yield of chemical cotton, cellulose yield, alpha cellulose and the dry alpha cellulose, in air dried linters are presented in Table II. The value of cellulose yield which is a very useful quality parameter from the commercial point of view, range between 67% to 83%. Such a wide fluctuation again is an indication to the amount of non-cellulosic materials present in tne raw linter samples. The ash content of raw linter samples varied between 0.99% to as high as 3.90%. This must be considered quite high. The high ash content of raw linters is mainly due to the presence of foreign materials like various parts of cotton plant, the broken seeds and the seed shavings which is the result of inefficient delinting practices adopted in the delinting units. In the case of ash content of chemical cotton the values vary between 0.002% to as high as 0.353%.

Eventhough many samples have ash content within the permissible level for the manufacture of various cellulose derivatives, in many others the ash content is quite high. Another interesting observation can be made when the values of ash content of raw as well as chemical cotton is compared. Different samples of raw linters having the same level of ash has yielded on purification end product having different ash contents For instance sample No. 13 and sample No. 22 having ash contents of 3.37% and 3 3 % have yielded chemical cotton having ash content of 0.11% and 0.036%. Many such cases can be found in the data presented. The reason for the above behaviour lies in the difference in the nature of their trash content[4].

The maximum permisible limit of ether soluble matter for various grades of raw linters as laid down in ISI 3517-1965 is 2.0% by weight. The values of the ether soluble matter of the samples under investigation vary between 0.32% to 1.00%. Even though, it is well within the limits, the variation is rather high.

The values of chemical cotton percentage represents the yield of purified linters under a particular set of conditions from raw linters. This important parameter varies between 58.9% to as high as 78-9%. Eventhough these values are roughly in the same order as the trash content, the anomalies arising between the values of the trash content and the chemical cotton yield can be attributed to the nature of the trash for that particular sample.

The alpha cellulose content of the chemical cotton varies between 94.5% and 98.5%. Eventhough the variation among the samples is not high. Only two samples have the alpha cellulose content more than 98% and half of the rest have alpha cellulose content more than 97%. On the whole the alpha cellulose content of the samples of the linters is fairly high Thd values of the dry alpha cellulose content of the air dried linters are also given as an additional quality parameter of raw linter samples. As can be observed the values range from as low as 57.1% to 76.9%. This is rather a high variation and a variation of this magnitude is undesirable from a commercial point of view. The above observed variation arises mainly due to the varying amount of trash materials present in the raw linters. the above data once again emphasises the need for an improvement in the pre-cleaning operation of cotton seed as well as cotton linters prevalent at present in our delinting units.

The degree of whiteness of all the samples were measured in terms of Whiteness Index using the Ber' ger's[5] formula. The Whiteness Index varies between 58 8% to 75.8%. The variation of this magnitude is not only undesirable from the commercial point of view but at the same time is difficult to explain as all the samp'es are bleached under identical conditions The above data on Whiteness Index gives substance to the common complaint from the linter consumers that under identical conditions of bleaching the degree of whiteness obtained is not the same in all samples. The above behaviour may most probably be attributed to

TABLE—II DETAILS GF GHEMICAL AND MECHANICAL ANALYSIS OF LINTERS

Sl. No.	CHEMICAL COTTON %	ASH % RAW	ASH % CHEMICAL COTTON	% ALPHA CELLULOSE	ETHER SOLUBLES %	% DRY ALPHA CELLULOSE	CELLULOSE YIELD% (A.O.C.S.)	FIBRE PERCENTAGE	TRASH PERCENTAGE	INVISIBLE LOSS%	WHITENESS INDEX
1.	.69 3	1.90	0.205	94.5	0.48	65.5	81	92	12	26	64.0
2.	5 .9	1.86	0.198	97.0	0.41	57.1	67	16	28	56	62.2
3.	64.8	2.20	0.154	97.0	0.50	62.9	74	58	20	22	66.2
4.	63.7	1.85	0.024	95.4	0.44	60.8	72	50	22	28	63.4
5.	70.6	2.23	0.213	94.4	0.47	66.6	79	69	16	15	75.2
6.	75.0	1.74	0.261	97.7	0.48	73.3	82	71	17	12	65.2
7.	71.2	3.48	0.178	95.1	1.06	67.7	76	74	15	11	70.8
8.	77.0	0.99	0.231	—	—	—	81	80	10	10	75.0
9.	78.1	1.55	0.002	97.1	0.46	75.8	83	70	18	12	69.0
10.	77.3	1.23	0.353	96.9	0.58	74.9	78	72	12	16	65.4
11.	72.5	2.17	0.165	96.8	0.52	70.2	81	64	20	16	73.0
12.	75.4	1.18	0.185	97.1	0.39	73.2	78	58	20	22	60.0
13.	75.9	3.37	0.110	97.0	0.69	73.6	83	83	10	7	67.6
14.	74.8	3.90	0.209	97.5	0.54	72.9	76	73	15	12	62.6
15.	71.3	3.07	0.197	97.6	1.00	69.6	77	78	14	8	58.8
16.	78.9	1.42	0.151	96.8	0.48	76.3	77	72	12	16	75.4
17.	72.6	1.53	0.340	98.1	0.44	71.3	75	66	18	16	76.2
18.	71.8	1.75	0.320	97.4	0.32	79.9	73	66	18	16	66.5
19.	79.3	1.37	0.016	97.0	0.36	76.9	82	88	10	2	71.3
20.	76 4	1.56	0.190	98.5	0.50	75.2	82	69	12	19	67.4
21.	73 5	1.57	0.088	96.8	0.75	71.1	70	67	18	15	66.8
22.	68.3	3.31	0.036	95.0	1.02	64.9	73	73	16	11	66.2

the nature of the trash as well as the material composition of the linters.

On the whole, to sum up, the results of the mechanical and chemical analysis of the Indian cotton linters do not point a very bright picture on the quality status of our linters. The results also show that the quality of the Indian linters can be vastly improved by effecting a stricter control on the pre-cleaning operations of cotton seeds before delinting. This is necessary in view of the growing commercial importance of this renewable source of pure cellulose.

References :

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5. ASTM Standard E 313-73.