CXCVII. THE COMPOSITION OF SOME LESS COMMON VEGETABLE FIBRES

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THE composition of many of the better-known vegetable fibres, which find commercial use in one way or another for textiles or cordage according to their properties, was recently determined, and at the same time an examination was made of the type of cellulose present [Norman, 1936]. It was shown that these fibres fall into two well-defined groups, one having only small amounts of xylan in the fibre cellulose, and the other in which the xylan is considerably higher. The so-called fine fibres, such as flax and ramie, fall in the first group, while the coarser fibres, such as manilla and sisal, must be included in the second. Through the courtesy of Sir Harry Lindsay and the Imperial Institute, it has been possible to examine a considerable number of additional fibres, mostly of tropical origin and not commonly met with. Few, in fact, find other than local usage, the isolation of the fibre from the tissue containing it being frequently carried out by primitive means only. The properties of a few of these fibres were such as to suggest that, if they were more easily obtainable, commercial development might be possible.

METHODS

As before, all samples were finely ground in a high speed mill wherever possible to pass a 60-mesh sieve. Sample 20 (Palmyra fibre) proved very resistant, being similar in this to coir, which it resembles. In this case the analyses had to be carried out on material far from homogeneous, which caused the cellulose determinations to be unsatisfactory.

The methods of analysis and their interpretation were described in the previous paper [Norman, 1936].

RESULTS

The analyses of these fibres, together with their common names (if any), origins, and botanical types are given in Table I. Many of them are somewhat similar in composition, containing cellulose in the neighbourhood of 75 % and 5–10 % lignin. There are some which deserve special comment. Sample 9, Nigerian jute, is almost identical with the Indian jute sample previously analysed, the only difference being a lower content of xylan. *Hibiscus cannabinus* (Sample 1) which is known as Bimlipatam jute contains only half as much lignin as true jute, but otherwise is not very different.

The two samples of *Urena lobata* (Samples 7 and 8) grown respectively in Uganda and India differ considerably in composition, the former being much lower in cellulose and a little higher in xylan than the latter. If the xylan is calculated as a percentage of the cellulose containing it (Table II), this is the more apparent. *Sida rhombifolia* from Sierra Leone and India (Samples 15 and 16) is very similar, the percentage of lignin in the former being a little greater.

Palmyra fibre (Sample 20) stands out from all the other fibres examined in its high content of lignin, resembling coir in that and in other characteristics.

Table I. *Composition of fibres*
All results expressed as % of oven-dry material

No.	Fibre and source	Botanical type*	Cellulose	Lignin	Total furfur-aldehyde	Cell furfur-aldehyde	Xylan in cellulose	Furfur-aldehyde from poly-uronides
1	<i>Hibiscus cannabinus</i> (Bimlipatam jute), India	<i>a</i>	76.61	5.95	11.30	8.90	13.8	2.4
2	<i>H. diversifolius</i> (Kanyamberege), Uganda	<i>a</i>	72.63	9.06	10.70	7.36	11.4	3.6
3	<i>H. rostellatus</i> (Kansambwe), Uganda	<i>a</i>	77.86	6.64	11.58	8.89	13.8	2.7
4	<i>Triumfetta rhomboidea</i> (Bwensambwe), Uganda	<i>a</i>	60.39	11.18	10.21	6.48	10.0	3.7
5	<i>T. tomentosa</i> (Binsambwe), Uganda	<i>a</i>	71.48	9.05	9.77	6.88	10.7	2.9
6	<i>Abutilon indicum</i> (Kifala), Uganda	<i>a</i>	72.18	10.59	13.75	9.62	14.9	4.1
7	<i>Urena lobata</i> (Kansambwe-Kasaja), Uganda	<i>a</i>	63.46	7.81	13.10	9.24	14.3	3.9
8	<i>U. lobata</i> , India	<i>a</i>	76.92	6.87	12.86	8.66	13.4	4.2
9	<i>Corchorus capsularis</i> (Green Jute), Nigeria	<i>a</i>	72.61	10.15	10.08	6.56	10.2	3.5
10	<i>Sterculia Barteri</i> (Eso), Nigeria	<i>a</i>	74.50	8.64	10.03	7.29	11.3	2.7
11	<i>Monodora brevipes</i> (Lakosin), Nigeria	<i>a</i>	72.58	10.75	10.59	7.04	10.9	3.5
12	<i>Grewia carpinifolia</i> (Itakan-Okiro), Nigeria	<i>a</i>	66.05	16.98	10.56	6.38	9.9	4.2
13	<i>Cola afzelia</i> (Obi Edun), Nigeria	<i>a</i>	75.60	9.85	12.19	8.87	13.7	3.3
14	<i>Abroma augusta</i> (Kowie), Sierra Leone	<i>a</i>	75.90	7.05	12.07	9.45	14.6	2.6
15	<i>Sida rhombifolia</i> (Helui), Sierra Leone	<i>a</i>	74.20	12.7	12.56	9.69	15.0	2.9
16	<i>S. rhombifolia</i> , India	<i>a</i>	74.84	10.22	13.21	9.88	15.3	3.3
17	<i>Honckenia ficifolia</i> (Napunti), Sierra Leone	<i>a</i>	74.35	10.66	10.8	8.49	13.2	2.3
18	<i>Sansevieria guineensis</i> (Bowstring hemp), Sierra Leone	<i>b</i>	75.06	7.31	12.35	7.95	12.3	4.4
19	<i>Malachra capitata</i> , India	<i>a</i>	73.41	8.27	12.5	9.72	15.1	2.8
20	<i>Borassus flabellifer</i> (Palmyra fibre), India	<i>c</i>	63.50†	25.01	13.80	10.16	15.7	3.6
21	<i>Crotalaria juncea</i> (Sunn hemp), India	<i>a</i>	79.27	5.24	3.18	1.96	3.1	1.2
22	<i>Adansonia digitata</i> (Baobab fibre), Rhodesia	<i>a</i>	67.26	5.64	12.77	7.95	12.3	4.8
23	<i>Furcraea gigantea</i> (Mauritius hemp), Mauritius	<i>b</i>	79.83	4.83	13.24	9.85	15.3	4.4
24	<i>Ananas sativa</i> (Pineapple fibre), Sudan	<i>d</i>	79.62	5.50	10.45	7.22	11.2	3.2
25	<i>Bromelia Magdalenae</i> (Pita fibre), South America (Colombia)	<i>d</i>	76.35	6.93	9.67	6.80	10.5	2.9
26	<i>Bactris setosa</i> (Tucum palm fibre), South America	<i>c</i>	81.54	7.42	5.13	3.10	4.8	2.0
27	<i>Eriodendron anfractuosum</i> (Kapok fibre),† Java	<i>e</i>	65.67	14.58	13.59	9.78	15.1	3.8

* Botanical type: *a*, bast fibres from dicotyledon stem; *b*, sclerenchymatous fibre bundles with residues of vascular bundles; *c*, vascular bundle with sheath of sclerenchymatous fibre; *d*, bundles of sclerenchymatous fibres accompanying vascular bundles; *e*, hairs from inner wall of fruiting capsule.

† This figure is less reliable than other cellulose determinations.

‡ This sample was extracted with alcohol-benzene before analysis.

Table II. *Xylan as % of cellulose*

Sample	Xylan	Sample	Xylan	Sample	Xylan
1	18.0	10	15.2	19	20.5
2	15.7	11	15.0	20	24.7
3	17.7	12	15.0	21	3.9
4	16.6	13	18.2	22	18.3
5	14.9	14	19.3	23	19.1
6	20.6	15	20.2	24	14.1
7	22.6	16	20.4	25	13.8
8	17.4	17	17.7	26	5.9
9	14.0	18	16.4	27	23.1

Although grinding was difficult and the cellulose figure consequently not so accurate as in other samples, the cellulose appears to be appreciably higher than in coir, which averages about 54%. Coir, on the other hand, has the greater lignin content. The total furfuraldehyde yield and the percentage of xylan in cellulose are about the same in these two fibres.

Sunn hemp (Sample 21) from India is found closely to resemble the European hems previously examined. The cellulose is similar in containing only a small quantity of xylan, and this fibre must be added to the small group of low xylan type. *Sansevieria guineensis*, the so-called bowstring hemp, and *Furcraea gigantea*, Mauritius hemp (Samples 15 and 23) are not true hems, though the latter contains as much cellulose as Sunn hemp. The cellulose of both is relatively high in xylan, and these fibres must accordingly be allocated to the high xylan group.

Baobab fibre (Sample 22) is derived from the bark of a tree, and as might be expected is lower in cellulose than the majority of others examined, but at the same time it is not high in lignin, nor is the xylan in the cellulose as high as in most wood celluloses.

The analyses of Sample 25, Pita fibre from Colombia, differ considerably from those obtained on "Pita grass" and reported earlier. There is however some confusion in the description of this fibre. The results suggest what was suspected at the time from the unusually high cellulose content, that the samples of this fibre previously examined had been subjected to some purification process resulting in partial delignification. The xylan calculated as % of the cellulose is very similar in all the samples.

Tucum fibre or Tucum palm fibre (Sample 26) is separated from the leaves of this palm, common in the Amazon valley and along the coasts of Brazil. The fibre is high in cellulose and contains about 7% lignin. The most noteworthy feature, however, is that the furfuraldehyde yield is low and the xylan in the cellulose under 5%. This is unique in being the only leaf fibre yet found to be of the low xylan type. The fibre is fine, very strong and durable, but at present finds little other than local use in Brazil where it is utilized for fishing nets, bags and ropes.

Kapok (Sample 27) is found in the seed bolls of a tree, *Eriodendron anfractuosum*, but is entirely different in composition from cotton. The cellulose content is only about 65%, and the cellulose is exceptionally high in xylan. From the appearance of the fibre it was not to be expected to be more lignified than jute or *Phormium*. Treatment with alcohol-benzene was found essential before analysis, and the results are expressed on fibre so treated.

DISCUSSION

It has been pointed out that the common fibres are divisible into two broad groups, on the basis of the xylan content of the cellulose present, and that this division does in fact separate the high quality textile fibres from those of coarser type. The additional fibres now examined permit only the addition of two, Sunn hemp and Tucum palm fibre, to the low xylan group. The remainder all contain upwards of 13 % xylan calculated on the cellulose (Table II). The degree of lignification is no indication of the type of cellulose to be met with, although no highly lignified fibres have been found to be of the low xylan type. There does not at present seem to be any reason why it is possible to group plant celluloses in this manner, the low-xylan group with 0-6 % and the high-xylan group with 13-25 % culminating in the hardwoods and straws. No cellulose with xylan between 6 and 13 % has been isolated in this laboratory although a very wide range of plant material has been examined.

There is clear evidence that the proportion of xylan changes during development, but none which suggests that the function of the tissue in any way affects the type of cellulose that may be present. Division into two groups according to xylan content may be an over-simplification, since no account is taken of the relatively short chain hexosan component that occurs with xylan in many plant celluloses. This ill-defined group about which information is not easy to obtain does not necessarily have the same distribution as the xylan.

SUMMARY

The composition of a number of less common vegetable fibres, mostly of tropical origin, is given. With two exceptions, Sunn hemp and Tucum palm fibre, the cellulose of all samples was found to contain over 13 % xylan.

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REFERENCE

Norman (1936). *Biochem. J.* **30**, 831.