DIFFERENCES BETWEEN FLAX AND HEMP

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Abstract

Differentiating flax and hemp is a long-time analytical problem, which is becoming more and more relevant with the wider loading of bast fibres. Flax and hemp are very similar fibres in all aspects, and their differentiation is often controversial. In this work, the literature is researched for the classic methods of differentiating these two types of fibres. Additionally, a further to twist discrimination methods (the twist test method and the method using polarised light) were analysed. The method most suitable for practical use was tested on a wide spectrum of fibres and compared with the usual methods.

Keywords

flax, hemp, analytic method, twist test

Properties of flax and hemp

Flax (in fibre form) is practically undifferentiated from hemp, which threatens possible confusion with the latter, which is considerably different in price. Flax and hemp are cellulose fibres produced from stocks of row material. Their properties are similar and they are scarcely differentiated at the fibre form. Analytical differentiation is complicated by strong interventions into these fibres during the textile treatment, which is similar in both flax and hemp: the fibres are separated, blanched, and undesirable additions are removed. These operations are connected with the change of average chemical composition of fibre material, e.g. the concentration of lignin decreases, the portion of low molecular celluloses decreases and the macromolecules of cellulose are abbreviated. There is also a wide variance in fibre characteristics at wide intervals, e.g. the specific strength of fibres and the length of fibre fluctuations.

Table 1. Comparison of the properties of flax and hemp: [1,2,3,4,5,6,7]

Property	Flax	Hemp
Cellulose content	65-87% (blanched, up to 98%)	under 80% at technical ripeness
Lignin content	small	greater than flax
Density	1460 – 1500 $kg.m^{-3}$	1480-1500$kg.m^{-3}$
Length of elementary fibres*	3 – 60 mm	4 – 55 mm
Shape of cross-section by elementary fibre	5- to 7-sided, with sharp peaks	polygon with rounded peaks
Moisture	12%	13%
Fineness	0.25 – 0.33 tex	0.25 – 0.38 tex
Breaking length	52 km	30 – 50 km
Elongation at break	1 – 2.5% dry 2 – 4% wet	2% dry 4% wet
Elasticity	slight	slight
Shape of lumen	small, less apparent even at the dotted form	broad, dashed (rarely circular)
Ends of the elementary fibres	sharp	dull or forked

* the values cited significantly vary at particular quoted sources

The results of some analytical methods of differentiating flax and hemp depend on the number of elementary fibres in the bundle. For this reason it is possible to recommend releasing the elementary fibres from the bundles before applying any other differentiating methods (especially microscopic differentiation) In the analytical literature [8]the following process is recommended: boiling the fibre sample for 30 min in a 10% sodium bicarbonate solution (or 2% caustic soda solution) removes the pectin substances. The elementary fibres can then be released by friction between the fingers.

Review of analytical methods resulting of literature research [9,10,11]

Microscopic differentiation

The morphological characteristics mentioned in Table 1 can be used for microscopic differentiation of flax and hemp. The observation is mostly oriented towards the observation of the shapes of the fibre's cross-sections and fibre ends at the longitudinal view. This method is time-consuming (requiring preparations to be prepared), the appreciation of the characteristics observed is rather subjective, and it also requires considerable experience. An advantage is the fact that the shape of the elementary fibres does not change during the processing.

Swelling test

Various morphological structures of flax and hemp are exhibited by the diverse extents of the swelling property of the fibres. in the cuoxam solution. The flax swells uniformly and relatively rapidly, the tube in the non-blanched fibre contracts in a serpentine fashion, and it resists the solvent. The hemp swells slowly; during this process the tube in the raw fibre often obtains a typical periodic-shape. The swelling of the flax and the hemp has been photographically documented by Koch [8] and Felix [9]. For observing fibres it is necessary to use the microscopic technique.

Dyeing tests

Hemp contains more lignin and non-cellulose portions than flax. On this basis, a group of tests has been prepared in which the dyestuff of the agent is e.g. sorbed only by the lignin part of the fibre, for example, or when the agent reacts with the non-cellulose parts of the fibre depending on the colour compound applied. Dyeing tests are especially applicable to raw fibres before eliminating non-cellulose substances from fibres (preliminary finish or otherwise); after their elimination, the fibres will not colour. The methods are easily executed, and their results are apparent by visual evaluation even without microscopic equipment.

Table 2. Behaviour of flax and hemp dependent on the dyeing

Dyeing reaction	Behaviour	
	flax	hemp
Fluoroglucine reaction*; reaction to the pentoses – in this reaction the medium is based on furfural)[12,9,10]	it does not dye the fibre, or possible dyes light pink [13]	dark pink colour of the fibre
Cyanin reaction [9]	non-coloured fibre	blue-green colouring of the fibre
p-nitranilin reaction (reaction on the lignin) [14]	non-coloured	light pink

* Some sources [15] denoted it as a reaction to the lignin

Cyanin reaction:

- 70 ml of Chinolin Blue solution (when cold, it is a saturated solution) + 5 ml water + 25 ml of clear glycerin;
- when warm, the flax is uncoloured but the hemp obtains a blue-green colouring.

Fluoroglucine reaction: [9]

- dissolve the fluoroglucine in 96% alcohol to coffee-brown colour;
- 3 minutes' effect on the sample at a non increasing temperature;

- suck off the excess of agent;
- dissolve crystallised fluoroglucine in added alcohol;
- add concentrated hydrochloric acid;
- the reaction will run over 3 - 5 min.

Alternative process of the fluoroglucine reaction: [10]
- dissolve 2g of the fluoroglucine in 100ml of alcohol;
- directly before using, 10 ml of hydrochloric acid is added.

p-nitranilin reaction:
- 2 g of the p-nitranilin is dissolved in 80ml of water, 20ml of concentrated hydrochloric acid is added.

Summary of standard methods

Standard methods (microscopic, swelling and dyeing) of distinguishing of the flax and hemp are not very reliable for routine differentiation of flax and hemp, and are rather subjective because they are based on observing the characteristics which vary only a little between flax and hemp. The characteristics observed can acquire the same values for both flax and hemp, depending on the degree of processing of the fibres tested.

Twist tests - Indirect method of determination of fibril slope in the flax and the hemp [15]

Flax and hemp have different orientations of fibril bundles in the fibre. Indirectly, this fact is verified by the opposing behaviour of flax and hemp in polarised light (as directed from above), and by the possibility of distinguishing the fibres by X-ray diffraction.

From the analytical aspect, the orientation of the fibrils at the hydration and dehydration of lamellas is important. During these processes, changes to the geometry characteristics of the fibril bundles occur. These changes are macroscopically expressed by the fibre's effort to turn, and so eliminate the internal stress at the sorption (or desorption) of water. Sonntag [16]used this method for the analytical distinction of flax and hemp.

The so-called 'Twist test' method for differentiating flax and hemp is founded on this basis, , the merit of which is the observation of the spontaneous twisting of the fibre as it dries. If a wet flax is held by one end and dried, then its free end, which is oriented towards the observer, will turn clockwise (right handed, according to Figure 3). Under the same conditions, hemp will turn round in the opposite direction. The direction of twisting is characteristic for both flax and hemp, whereas cotton fibres twist in various directions during this test. Ramie twists as flax. [15] This process described in literature [15] was modified according to the possibilities of our laboratory and is presented below.

Process of twist test

1) Samples of tested fibres were put into the container with distilled water at room temperature. The samples were left for ca. 5 min in the bath (even longer is possible).
2) One fibre is removed from the bath and fixed into the holder so that the part of fibre of ca. 20mm protrudes from the holder (Figure 1). (The experiment cannot be evaluated with a length of protruded fibre under 10 mm or above 30 mm.)

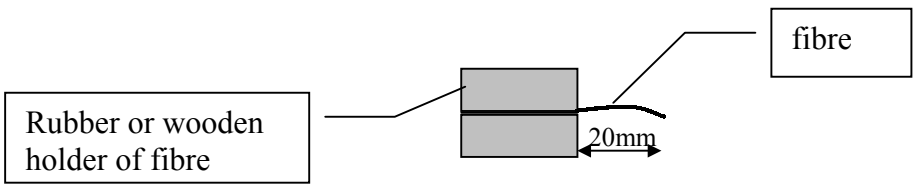


Figure 1. Fibre holder

3) The holder with the fibre is put on a heated plate (Figure 2) with the temperature of ca. 80°C. (This is a black solid ceramic or glass desk which was tempered in the drying oven at100°C for ca. 20 min.)

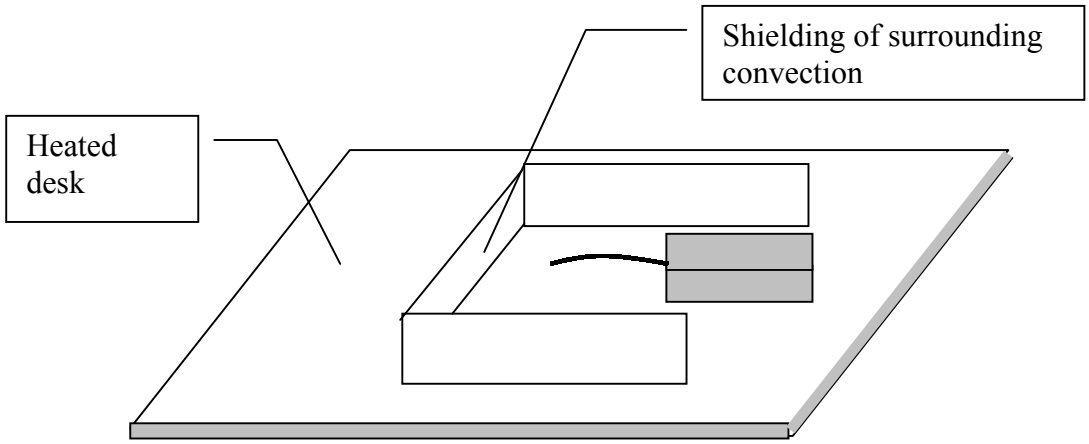


Figure 2. Test stand

4) We observe the rotation of the fibre during drying above the heated plate. (The fibre can be wetted again in the holder (by immersion into the liquor) and repeatedly observed when dry on the plate.).

Flax twists during drying in the right-handed direction **P**, hemp in the left-handed direction **L.**

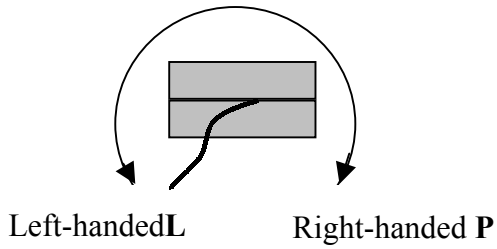


Figure 3. Fibre turning directions

Results

Table 3. Results of experiments

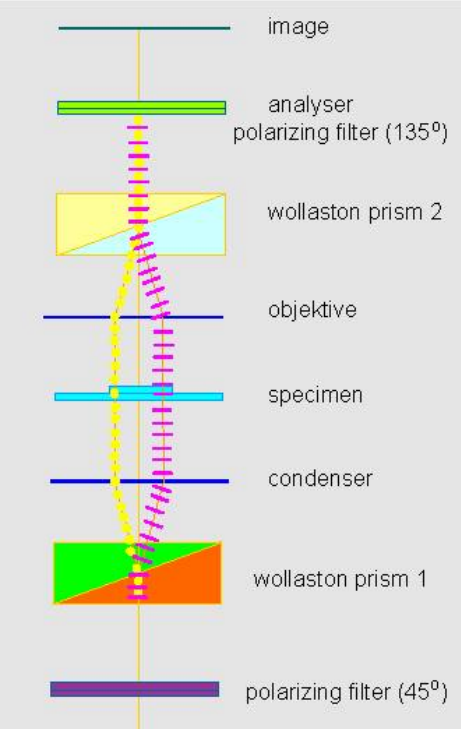
No.	Source of the fibre (firm, city)	sample description	declared material	results of the tests	
				twisting	fluoroglucine[10]
kn/1	VÚB, Ústí n. Orlicí	100 kn F5	hemp	L	non-coloured
kn/2	TUL, Liberec	(from teaching)	hemp	L	dark pink
kn/3	Agritec, Šumperk	Hemp	hemp	L	dark pink
kn/4	Inotex, Dvůr Králové	Hemp noils Rumunsko	hemp	L	light pink
kn/5	Inotex, Dvůr Králové	Markus hemp	hemp	L	light pink
kn/6	Inotex, Dvůr Králové	Hemp Agritec	hemp	L	dark pink
kn/7	Inotex, Dvůr Králové	Hemp CDS 18	hemp	L	light pink
ln/1	VÚB, Ústí n. Orlicí	100 ln Geranium	flax	P	light pink
ln/2	VÚB, Ústí n. Orlicí	100 ln Markus	flax	P	light pink
ln/3	Inotex, Dvůr Králové	Flax Markus	flax	P	light pink
ln/4	TUL, Liberec	(from teaching)	flax	P	light pink

ln/5	TUL, Liberec	Less ln – sliver	flax	P	non-col.
ln/6	TUL, Liberec	len BRD2-biochem sliver	flax	P	non-col.
ln/7	TUL, Liberec	ln sliver original after m. defibration	flax	P	light pink
ln/8	TUL, Liberec	Geranium ln sliver	flax	P	light pink
ln/9	Agritec, Šumperk	Venica 1	flax	P	pink
ln/10	Agritec, Šumperk	Venica 2	flax	P	pink
ln/11	Agritec, Šumperk	Venica 3	flax	P	pink
ln/12	Agritec, Šumperk	Venica 4	flax	P	pink
ln/13	Agritec, Šumperk	Venica 5	flax	P	pink
ln/14	Agritec, Šumperk	Venica 6	flax	P	pink
ln/15	Agritec, Šumperk	Venica 7	flax	P	pink
ln/16	Agritec, Šumperk	Venica 8	flax	P	pink
ln/17	Agritec, Šumperk	Venica 9	flax	P	pink
ln/18	Agritec, Šumperk	Venica 10	flax	P	pink
ln/19	Agritec, Šumperk	Merkur 2001 28c	flax	P	pink
ln/20	Agritec, Šumperk	Jordán 2000 17 mk 8abc	flax	P	pink
ln/21	Agritec, Šumperk	Viola 2001 8c	flax	P	non-col.
ln/22	Agritec, Šumperk	Bozel 2000 24 mks/abc 2	flax	P	pink
ln/23	Texlen, Trutnov	sliver	flax	P	light pink
ln/24	Dvůr Králové	prepared from stalk, oil flax	flax	P	non-col.
ln/25	Inotex, Dvůr Králové	Markus Flax	flax	P	light pink

Note: In one (in Table 3 non-presented case the “hemp” twisted in the right-handed direction; this was probably flax, which had been declared incorrectly.

Differentiation of flax and hemp in polarised light [9,17]

Polarisation light microscopy can be also used for the identification of flax and hemp fibres.

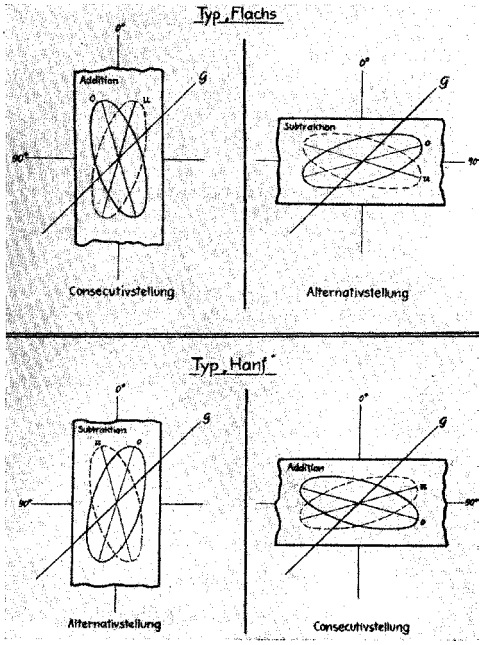


Polarisation light microscopy uses two polarisation filters. These filters are cross-planed across each other. In Figure 4 they are noted as the polarising filter (45°) and the analyser (135°). For emphasis of interference, the R.I. gypsum plate is applied in the optical system. Determining the birefringence of fibres is fundamental to observation in polarised light. Birefringence is defined as the difference of refractive index in parallel direction with the direction of fibre axis **n||,** and in vertical direction on the fibre axis **n⊥.**

$$D = n|| - n\perp$$

reflects the orientation of the fibre structure. If the orientation of structure is larger, so the birefringence is greater. Flax and hemp have high birefringence, and they differ only by the direction of the fibril slope in view of the fibre axis. This is shown in the figure on the left.

Figure 4. Schema of polarisation microscope



The fibres are defined as optically positive and optically negative by course of swelling or reducing of interference colours after applying the R.I. plate.

The optically positive fibres (at the position of +45° on the axis of the R.I. plate) show the swelling of colours (additivity), and at the position of -45° they show the reduction of colours (subtractivity). These relations are opposite in the optically negative fibres.

Figure 5. Optical birefringence. Additivity and subtractivity of fibres [17]

Conclusion

The tested methods of differentiating flax and hemp based on the orientation of fibril bundles (the 'Twist test' and differentiation in polarised light) are reliable and fast. Their basis does not depend on the degree of fibre treatment. These methods also have minimal demands on the laboratory equipment and staff.

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