Bast Fibres: Examples and Properties of Flax, Hemp, Jute, Ramie and Kenaf

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In one paragraph

Bast fibres (also spelt bast fibers) are the long, thick-walled fibre cells that grow in bundles in the phloem, or inner bark, of the stems of certain plants, mostly dicotyledons, where they give the stem its strength. The textile bast fibres are flax (linen), hemp, jute, ramie and kenaf, followed by roselle, sunn hemp, nettle and a few others. Each strand that comes out of the stem is a string of short “ultimate” cells cemented together by pectin, so the fibre is freed by retting (letting microbes digest the pectin), by stripping and scraping, or, for ramie, by chemical degumming. The five main bast fibres differ most in how long those cells are and how much lignin they carry: a ramie cell is typically 40–250 mm long with about 1% lignin, a jute cell 2–2.5 mm with 11–26%. Cell length is the main reason ramie and flax spin into fine, linen-like yarns and jute into hessian and sacking.

At a glance

Bast fibres at a glance

Fibre	Plant	Where most of it is grown	Ultimate cell length	Main uses
Flax (linen)	Linum usitatissimum	France, then Belgium (FAO, 2024)	10–40 mm	Linen cloth; tow for paper and industrial uses
Hemp (“true hemp”)	Cannabis sativa	France, then China (FAO, 2024)	5–40 mm (primary fibres)	Yarn, twine, rope, nets, paper
Jute	Corchorus capsularis (white jute), C. olitorius (tossa jute)	Bangladesh 56%, India 38% (FAO, 2024)	2–2.5 mm	Sacking, hessian (burlap), carpet backing
Ramie	Boehmeria nivea	China 95% (FAO, 2024)	40–250 mm	Grass cloth, blends with cotton, silk, wool and polyester, nets, canvas
Kenaf	Hibiscus cannabinus	India, Russia, China (FAO, 2024, with other jute-like fibres)	2–3 mm	Sacking, hessian, twine and rope, alone or mixed with jute; paper pulp

Bast fibres compared: properties of flax, hemp, jute, ramie and kenaf

Structure and physical	Flax	Hemp	Jute	Ramie	Kenaf	Source
Ultimate cell length, mm	10–40 (1–100); 6–80	5–40 primary, about 2 secondary; 5–55	2–2.5 (0.5–6.5); 1–6	40–250 (10–600); 120–150	2–3 (1.5–12); 2.1–2.7	PROTA (flax, hemp), PROSEA (jute, ramie, kenaf); Bourmaud 2018, Table 1
Ultimate cell width, µm	10–30 (5–40); 12.4–23.9	10.9–42.0 (review)	15–20 (9–33); 15–35	25–60 (10–100); 10–50	15–25 (7–41)	PROTA (flax), PROSEA (jute, ramie, kenaf); Bourmaud 2018, Table 1

Structure and physical	Flax	Hemp	Jute	Ramie	Kenaf	Source
Density, g/cm³	1.53–1.54	1.4–1.6	1.38–1.40; 1.46 (IJSG, true density)	1.5	1.45	All from Bourmaud 2018, Table 1, except jute's 1.46 from IJSG
Agreed moisture allowance for EU fibre labelling, %	12	12	17	8.5 (bleached)	17 (labelled as jute)	Regulation (EU) No 1007/2011, Annex IX

Key figures and their sources

- Even the two handbooks disagree on flax: PROSEA's flax entry gives 2.7–3.2% elongation and a modulus of 27.6 GPa (PROSEA, flax), PROTA's 1.3–3.3% and 27–80 GPa.
  Source: PROSEA, flax (uses.plantnet-project.org)
- Measured regain depends on the air: IJSG gives jute 13.8% at 65% relative humidity and 36.0% at 100%, and 17% is the agreed allowance for jute (IJSG; Annex IX).
  Source: IJSG (web.archive.org)
- Jute rets fastest at a water temperature of 34 °C, but the fibre comes out harsher and less bright, and slowly moving water gives the best quality (PROSEA, jute).
  Source: PROSEA, jute (prosea.prota4u.org)
- ICAR reports that it raises fibre quality by one to two grades, shortens retting by 7 days and cuts the water needed by 75% (ICAR).
  Source: ICAR (icar.org.in)
- In Europe hemp is cut by machine, left to dry in swathes on the field for a few weeks, then pressed and baled, with an average fibre yield of about 15% (PROTA, hemp).
  Source: PROTA, hemp (uses.plantnet-project.org)

Formulas and diagrams

> One converts to the other through density: stress in MPa = tenacity in cN/tex × density in g/cm³ × 10.

> So tenacity = stress ÷ (density × 10).



Plant fibre samples. The top row and the jute sample are bast fibres; coir comes from the coconut fruit, and wood, corn and grass are shown for comparison. Image source not recorded.



Hanks of bast fibre, published by Ecomaniac as ramie. The photographer is not recorded.

Revision questions

The questions readers ask most, with the article's own answer.

What is the meaning of bast fibre?

A bast fibre is a fibre taken from the bast, the phloem or inner bark, of a plant stem, rather than from a seed, a leaf or a fruit. The fibres lie in bundles between the woody core and the skin and give the stem its strength.

What are examples of bast fibres?

Flax (linen), true hemp, jute, kenaf, roselle, ramie and sunn hemp are the commercial ones; nettle, lime (linden) bast and broom are minor ones. Cotton is not a bast fibre (it is a seed hair), nor are sisal and abaca (leaf fibres) or coir (from the coconut fruit).

Is jute the same as hemp?

No. Jute comes from Corchorus plants grown mostly in Bangladesh and India; hemp comes from Cannabis sativa.

What is jute made of?

Jute fibre is mostly cellulose, with hemicellulose and lignin. IJSG gives 58–63% α-cellulose, 21–25% hemicellulose and 12–14% lignin, with under 2% each of pectin, fats and waxes, protein and ash, depending on whether it is white or tossa jute.

What is ramie fibre?

Ramie, also called China grass, is the bast fibre of Boehmeria nivea, a plant of the nettle family grown from rhizome cuttings, and China grows about 95% of it. Its cells are the longest of the main bast fibres and almost free of lignin, but the raw fibre is so gummy that it has to be chemically degummed rather than retted.

What is the difference between flax and jute?

Flax is the fine bast fibre and jute the coarse one. Flax cells are 10–40 mm long with little lignin, so flax is hackled into long line fibre and spun into linen; jute cells are 2–2.5 mm long and more lignified, so jute goes into hessian, sacking and carpet backing.

Test yourself

Ten questions on this topic. Answer them without looking, then check on the last page.

1. What is the technical fibre of a bast plant, and how many ultimate cells does a flax bundle hold?
2. Why can jute not be spun into fine yarn?
3. What formula links fibre stress in MPa to tenacity in cN/tex?
4. Compared with dew retting, what does water retting give, and at what cost?
5. At what water temperature does jute ret fastest, and what is the drawback?
6. What are the basic steps in degumming ramie?
7. In flax processing, what are line and tow?
8. Why is flax pulled from the ground rather than cut at harvest?

9. What is the measured regain of jute at 65% and at 100% relative humidity (IJSG), and its EU agreed allowance?

10. Under the microscope, what cell feature does PROSEA describe as characteristic of jute?

Answers

Each answer is stated in the article; the section to read again is named after it.

1. **A strand of many ultimate cells still cemented together; a flax bundle holds 10–40 cells.**
   See: What is a bast fibre?
2. **Its length-to-diameter ratio is only 100–120, against a minimum of 1,000 for fine spinning.**
   See: Bast fibres compared: properties of flax, hemp, jute, ramie and kenaf › Why the sources disagree
3. **Stress in MPa = tenacity in cN/tex × density in g/cm³ × 10.**
   See: Worked example: converting fibre strength in MPa to tenacity in cN/tex
4. **More even, higher-quality fibre, at the cost of a polluting, foul-smelling effluent.**
   See: How bast fibres are extracted: retting, decortication, degumming, scutching and hackling › Retting
5. **34 °C; the fibre comes out harsher and less bright.**
   See: How bast fibres are extracted: retting, decortication, degumming, scutching and hackling › Retting
6. **An alkaline boil, washing, bleaching with an oxidising agent, washing again and oiling.**
   See: How bast fibres are extracted: retting, decortication, degumming, scutching and hackling › Decortication and degumming
7. **Line is the long fibre that survives hackling, ready to spin; tow is the short by-product.**
   See: How bast fibres are extracted: retting, decortication, degumming, scutching and hackling › Breaking, scutching and hackling
8. **To keep the full length of the fibre.**
   See: Flax vs jute, and ramie vs hemp
9. **13.8% at 65% RH, 36.0% at 100% RH; the EU allowance is 17%.**
   See: Bast fibres compared: properties of flax, hemp, jute, ramie and kenaf › Why the sources disagree
10. **Spoon-shaped cell ends.**
    See: Testing bast fibres: the standards that apply

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