EXTRACTION METHOD OF FLAX FIBRE AND ITS USES

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Abstract

Flax (Linum usitatissimum) is a bast fibre plant cultivated for the production of fibres, for use in a wide range of woven and non-woven end uses. Bast fibres are also known as ‘soft’ fibres or skin fibres and are characterised by their fineness, strength and flexibility, which distinguishes them from the coarser and less flexible fibres of the leaf, or “hard,” fibre. Flax is a renewable resource and has the potential to be much more eco-friendly than cotton. Linen fibres are obtained from the inner bark (or skin) of a plant. Flaxseed fibre is a high quality, organic, natural, unrefined whole food product that is naturally gluten free with a shelf life of two years, as reported by the manufacturers. The fibres support the conductive cells of the phloem and provide strength to the stem. Traditionally, the production of fibre from flax has focused on long fibres for use in the manufacture of linen yarns. However, short-fibre flax can also be produced and processed to be a ‘cottonised’ fibre for the production of textile yarns on cotton processing equipment. Flax fiber is a raw material used in the high-quality paper industry for the use of printed bank notes and rolling paper for cigarettes and tea bags.

Key words: Flax, fiber, linen, retting, scutching, heckling.

Introduction

Flax (also known as common flax or linseed), with the binomial name Linum usitatissimum is a member of the genus Linum in the family Linaceae, which has been grown throughout the world for millennia is the source of products for existing, high-value markets in the textile, composites, paper/pulp and industrial/nutritional oil sectors (Hamilton, 1986; Sharma and Sumere, 1992). It is a food and fiber crop that is grown in cooler regions of the world. Originally cultivated in Mesopotamia, the use of flax has been documented as far back as 3000 BC (Cunnane and Thompson, 1995). In addition to referring to the plant itself, the word “flax” may refer to the unspun fibers of the flax plant. Flax fiber is extracted from the bast or skin of the stem of the flax plant. Flax fiber is soft, lustrous and flexible, bundles of fiber have the appearance of blonde hair, hence the description “flaxen”. It is stronger than cotton fiber but less elastic. Flax is the source of industrial fibers and as currently processed, results in long-line and short fibers (Van Sumere, 1992). Long line fiber is used in manufacturing high value linen apparel, while short staple fiber has historically been the waste from long line fiber and used for lower value products. The best grades are used for linen fabrics such as damasks, lace and sheeting. Coarser grades are used for the manufacturing of twine and rope and historically for canvas and webbing equipment. Flax fiber is a raw material used in the high-quality paper industry for the use of printed bank note sand rolling paper for cigarettes and tea bags. Flax mills for spinning flaxen yarn were invented by John Kendrew and Thomas Port house of Darlington in 1787. New methods of processing flax and the rising price of cotton have led to renewed interest in the use of flax as an industrial fiber.

Biology

Cultivated flax (Linum usitatissimum) is an annual of temperate climates, especially of northern Europe. This plant grows to a height up to 60 cm, with slender and very fibrous stems, lanceolate leaves having three veins, up to 4 cm long and 4 mm wide, and its bright blue flowers are up to 3 cm in diameter. The fruit contains a seed known as flaxseed or linseed (Pradhan et al., 2010). Separate varities are grown either for the fibre or for the seeds that are used in linseed oil production after flowering, the whole plant is pulled to obtain the maximum length of fibre.

Types of flax

To date, no method of flax cultivation has been
discovered that maximizes both quality and yield of both seed and fibers. To obtain the highest quality flax fibers, one must harvest before the plant fully matures, which results in poorer-quality oil. Conversely, if harvest is undertaken after maturation to obtain the best oil, the fiber quality deteriorates. Thus, two distinct types of flax plants are cultivated.

- The linseed type is grown primarily to extract the seed’s highly nutritious oil. This type is fairly short and produces many secondary branches, which increases seed yield.
- The flax type tends to grow taller, more slender, and with less branches. It is cultivated in order to extract the very long fibers from inside the wooden stem of the plant, which are then spun and woven into linen fabric. The taller the flax plant, the longer the fiber.

**What is flaxseed fiber**

Harvested deseeded stalks (up to first branching) are completely dried and subjected to wet retting for 2-3 weeks. Fibres are then separated from the vetted stock by scotching and drying (Chouhan et al., 2009). Long line fiber is used in manufacturing high value linen apparel, while short staple fiber has historically been the waste from long line fiber and used for lower value products. Retting, which is the separation of bast fibers from the core tissues, is preeminent in flax fiber processing, as it affects quality and yield (Pallesen, 1996). Flaxseed flake is the product that remains after the cold extraction of the oil from flaxseed and is sometimes referred to as de-fatted flaxseed. With the appearance of bran flakes, flaxseed flake can be milled to various degrees of coarseness, from a coarse meal to fine flour. Flaxseed fibre is a high quality, organic, natural, unrefined whole food product that is naturally gluten free with a shelf life of two years, as reported by the manufacturers. High temperature screw press extraction of flaxseed on a large scale results in oil that is inedible and is used in paints and varnishes. The residual meal suffers from degradation of the proteins and oil. Low temperature gentle extraction produces good quality polysaturated oil (rich in the omega-3 alpha-linolenic acid) with a residual meal that contains high quality protein and un-oxidized oil which should be a significantly more stable food ingredient than whole flaxseed meal.

**Cultivation**

The soils most suitable for flax, besides the alluvial kind, are deep loams, and containing a large proportion of organic matter. Flax is often found growing just above the waterline in cranberry bogs. Heavy clays are unsuitable, as are soils of a gravelly or dry sandy nature. Farming flax requires few fertilizers or pesticides. Within eight weeks of sowing, the plant will reach 10–15 cm (3.9–5.9 in) in height and will grow several centimeters per day under its optimal growth conditions, reaching 70–80 cm (28–31 in) within fifteen days. Flax is ready to be harvested for its fibers when the stem begins to turn yellow and the seeds turn brown. On some farms however, the plant is harvested prior to seed germination. This yields exceptionally fine fibers, but leaves the grower without any seeds for the next planting and subsequently dependent upon foreign imports. The stems of the flax plant are preferably pulled up with the root system somewhat intact, rather than cut at the base. This maximizes the quality of the fiber in several ways. First, the valuable fibers run the length of the stalk all the way into the roots, so pulling up the plant by the root increases the length of the fiber produced. This practice also prevents the plant sap from leaking out of the cut stalk, a process, which dries out the fibers and ultimately results in poorer-quality fabric. Although the agricultural industry has made great strides in mechanized farming, machine harvesting of flax is still unable to preserve the root system during harvest. For this reason, despite the extremely laborious process of manual harvesting, the highest quality linens are still made from flax plants that were pulled out of the earth by hand. Fabric made from hand-harvested flax is finer, more supple, and more highly prized than fabric made from flax that is machine-harvested.

**Harvesting**

Flax is harvested for fiber production after approximately 100 days, or a month after the plant flowers and two weeks after the seed capsules form. The base of the plant will begin to turn yellow. If the plant is still green, the seed will not be useful and the fiber will be underdeveloped. The fiber degrades once the plant is brown. Traditional methods for harvesting flax require specially made, sole-purpose and expensive equipment manufactured only overseas to pull and turn flax (Sultana, 1992).

**Methods**

There are two ways to harvest flax, one involving mechanized equipment (combines) and a second method, more manual and targeted towards maximizing the fiber length.

**Mechanical**

The mature plant is cut with mowing equipment, similar to hay harvesting and raked into windrows. When dried sufficiently, a combine then harvests the seeds.
similar to wheat or oat harvesting. The amount of weeds in the straw affects its marketability and this coupled with market prices determined whether the farmer chose to harvest the flax straw. If the flax was not harvested, it was typically burned, since the straw stalk is quite tough and decomposes slowly (i.e., not in a single season) and still being somewhat in a windrow from the harvesting process, the straw would often clog up tillage and planting equipment. It was common, in the flax growing regions of western Minnesota, to see the harvested flax straw (square) bale stacks start appearing every July, the size of some stacks being estimated at 10-15 yards wide by 50 or more yards long and as tall as a two-story house.

Manual

The mature plant is pulled up with the roots (not cut), so as to maximize the fiber length. After this, the flax is allowed to dry, the seeds are removed, and is then retted. Dependent upon climatic conditions, characteristics of the sown flax and fields, the flax remains on the ground between two weeks and two months for retting. As a result of alternating rain and the sun, an enzymatic action degrades the pectins which bind fibers to the straw. The farmers turn over the straw during retting to evenly rett the stalks. When the straw is retted and sufficiently dry, it is rolled up. It will then be stored by farmers before scutching to extract fibers. Flax grown for seed is allowed to mature until the seed capsules are yellow and just starting to split; it is then harvested by combine harvester and dried to extract the seed.

Threshing flax

Threshing is the process of removing the seeds from the rest of the plant. As noted above in the Mechanical section, the threshing could be done in the field by a machine, or in another process, a description of which follows:

The process is divided into two parts:

- The first part is intended for the farmer, or flax-grower, to bring the flax into a fit state for general or common purposes. This is performed by three machines: one for threshing out the seed, one for breaking and separating the straw (stem) from the fiber, and one for further separating the broken straw and matter from the fiber. In some cases the farmers thrash out the seed in their own mill and therefore, in such cases, the first machine will be unnecessary.

- The second part of the process is intended for the manufacturer to bring the flax into a state for the very finest purposes, such as lace, cambric, damask, and very fine linen. This second part is performed by the refining machine only.

The threshing process would be conducted as follows:

- Take the flax in small bundles, as it comes from the field or stack, and holding it in the left hand, put the seed end between the threshing machine and the bed or block against which the machine is to strike; then take the handle of the machine in the right hand, and move the machine backward and forward, to strike on the flax, until the seed is all threshed out.

- Take the flax in small handfuls in the left hand, spread it flat between the third and little finger, with the seed end downwards, and the root-end above, as near the hand as possible.

- Put the handful between the beater of the breaking machine and beat it gently till the three or four inches, which have been under the operation of the machine, appear to be soft.

- Remove the flax a little higher in the hand, so as to let the soft part of the flax rest upon the little finger, and continue to beat it till all is soft, and the wood is separated from the fiber, keeping the left hand close to the block and the flax as flat upon the block as possible.

- The other end of the flax is then to be turned, and the end which has been beaten is to be wrapped round the little finger, the root end flat, and beaten in the machine till the wood is separated, exactly in the same way as the other end was beaten.

Preparation for spinning

Before the flax fibers can be spun into linen, they must be separated from the rest of the stalk. The first step in this process is called retting. Retting is the process of rotting away the inner stalk, leaving the outer fibers intact. At this point there is still straw, or coarse fibers, remaining. To remove these the flax is “broken,” the straw is broken up into small, short bits, while the actual fiber is left unharmed, then “scutched,” where the straw is scraped away from the fiber, and then pulled through “hackles,” which act like combs to comb the straw out of the fiber. In Ireland ‘hackling’ was the term used for the final process in preparing flax for spinning into linen. A hackler, strictly speaking, is a person involved in the process of refining flax, which used to be grown in abundance in County Cavan, Ireland. Prior to the industry becoming mechanised and moving to East Ulster, it was a rural based cottage industry with Coote hill as Ulster’s largest market. The Hackler from Grouse Hall is an Irish song written in the late 1880s by a local man, Peter Smith, from Stravicnabo, Lavey. It has been sung by Christy...
In order to remove some of the flax fibers and it produces the least pollution. Retting can also be done in a plastic trash can or any type of water-tight container of wood, concrete, earthenware or plastic. Metal containers will not work, as an acid is produced when retting, and it would corrode the metal. If the water temperature is kept at 80°F (27°C), the retting process under these conditions takes 4 or 5 days. If the water is any colder, it takes longer. Scum will collect at the top, and an odor is given off the same as in pond retting. ‘Enzymatic’ retting of flax has been researched as a retting technique to engineer fibers with specific properties. the retting and mechanical processing steps work together to produce fibers, which are more precisely fiber bundles, of a particular fineness distribution. Variations in enzyme formulations used in retting can modify fiber properties, e.g., color, strength, and fineness (Akin et al., 2001, 2002) and information is needed on the specific fiber properties resulting from enzyme modifications, particularly related to subsequent cleaning.

**Dressing the flax**

Dressing the flax is the process of removing the straw from the fibers. Dressing consists of three steps: breaking, scutching, and heckling. The breaking breaks up the straw. Some of the straw is scraped from the fibers in the scutching process, and finally the fiber is pulled through heckles to remove the last bits of straw.

**The dressing is done as follows**

**Breaking:** The process of breaking breaks up the straw into short segments. To do it, take the bundles of flax and untie them. Next, in small handfuls, put it between the beater of the breaking machine (a set of wooden blades that mesh together when the upper jaw is lowered, which look like a paper cutter but instead of having a big knife it has a blunt arm) and beat it till the three or four inches that have been beaten appear to be soft. Move the flax a little higher and continue to beat it till all is soft, and the wood is separated from the fiber. When half of the flax is broken, hold the beaten end and beat the rest in the same way as the other end was beaten, till the wood is separated.

**Scutching:** In order to remove some of the straw from the fiber, it helps to swing a wooden scutching knife down the fibers while they hang vertically, thus scraping the edge of the knife along the fibers and pull away pieces of the stalk. Some of the fiber will also be scutched away; this cannot be helped and is a normal part of the process.

**Heckling:** In this process, the fiber is pulled through various different sized heckling combs or heckles. A
The flax plant supplies both industrial oil (i.e., linseed oil) and bast fiber used to produce textiles, composites, and paper/pulp. Linen has occupied a prominent place in textiles for centuries. Flax can be grown in many locations and is environmentally friendly (Foulk et al., 2002). Flax is a filament fiber harvested from flax plants that when made into fabric, is called linen, it is still widely used today, though it is less prevalent than it once was due to the ease of obtaining fabrics made of other fibers, such as cotton. Because flax is difficult to harvest it has become more costly to produce linen. Flax plants are used for many purposes, but the fiber itself comes from the stem and root of the flax plant, requiring careful harvesting, often done by hand. After the initial harvest, flax must be dried, soaked, crushed, combed and spun, creating a lengthy process that increases cost for consumers.

**Advantages of linen fabric**

- Excellent strength, gains strength when wet
- Hydrophilic: absorbs water and dries quickly
- Cool in warm weather
- Washable
- Withstands very high temperatures when washing and ironing
- No static, pilling, or lint problems
- Unique texture from the thick-and-thin pattern of the fibers

**Disadvantages of linen fabric**

- Wrinkles very easily
- Fair abrasion, low durability
- Poor drape and elasticity
- Expensive.
Conclusion

Flax is a renewable resource and has the potential to be much more ecofriendly than cotton. It requires far less use of pesticides and artificial fertilizers. It grows best under traditional farming methods where the crops are rotated and fields are allowed to lay fallow. It also benefits from a longer lifespan. The environmental impacts associated with water consumption, pollution and build-up of salts in soil are generally limited or avoided. Linen, like other Bast fibres can thrive well on land unsuitable for food production and may even assist the recultivation of soils previously polluted with contaminants such as heavy metals. An additional benefit is the longevity of the fibre, linen is up to twelve times stronger than the equivalent cotton product, which dramatically increases its life span and therefore does not need to be replaced so often. Linen absorbs dye well, especially natural dyes, and does not require chemical treatments. Natural flax colours range from shades of ivory, tan and grey. White or pure white is only achieved through various bleaching processes, but it can be sun bleached to avoid the use of artificial agents. Flax processing is, however labour intensive, and requires skilled workers. But it produces minimum wastage, as there are several by-products, these include linseed oil for linoleum, soap, fuel and cattle feed. Almost every part of its plant is commercially utilized either directly or after processing.

References


