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Reviewed Article:

Flax Fibre Extraction Techniques in the Late Middle Ages

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On its surface, linen production research is simple as there is a large corpus of books available; however, the majority of these date to the last three centuries. Older texts, while available, tend to concentrate on the textiles themselves and their trade. As a result, I had to collect the information on medieval tools and manufacturing process myself. I have grown and processed flax in a small open-air museum since 2014, and have been able to produce high quality fibre in 2016 and 2017. Although my parents in law came from a family which had processed flax, this knowledge had not been passed down and as a result I had to learn by reading and through practical experience. For my experiments I have grown fibre flax. Today

we distinguish two types of flax, for the extraction of linseed and for the extraction of fibre. In the Middle Ages, probably only one plant was cultivated that provided both (Knöchel and Vogeler, 2001 p.115). It is now possible to trace all the work steps and associated tools used in the Middle Ages. The most notable fact is that the devices used in non-industrial fibre extraction remained essentially unchanged over many centuries, which indicates that these early techniques had proven themselves to be optimal.

> After retting, the flax is dried again. This was often done in the fields in the same way as it was after harvesting. The flax is spread out thinly and turned every day, while being dried by the sun. Again, the greatest disadvantage is dependency on the weather. If the weather is bad, it can take a very long time for the flax to dry or, in the worst case, the whole harvest is lost.

Flax cultivation

Flax (summer flax) is an annual plant usually sown in mid-April when there are the best conditions for growing with sufficient rainfall. It is harvested about 100 days later. However, due to the climatic changes in modern times, I had problems with drought in spring, especially the last two years, and the crop required watering. In addition, the fibre quality was not so good because the plants had grown lower due to the drought. Winter-flax is sown in autumn and harvested the following year but this flax was rarely cultivated.

Summer flax's early sowing season means it is harvested at the end of July or the beginning of August. The hot and dry month of August is perfect for drying the flax after the harvest and for dew retting. Water retting is not as weather dependent, but for both harvests high temperatures shorten the retting time.

Flax is harvested when the lower third of the stem begins to turn yellowish and loses its leaves. The seeds will ripen while the flax is drying after the harvest. It is possible to harvest the plants while the stem is still green, which produces finer fibres, but the seeds won't ripen. Delaying the harvest too long will result in woody stems and unusable fibres.

I generally harvest my flax between 90 and 100 days after sowing. While the fibres of the earlier harvests were indeed finer, they also tended to be harder to extract especially close to the tips of the stem.

Pulling and Drying

Early Egyptian wall paintings show the flax plant being harvested by pulling the plant out of the ground root (Klebs, 1915, pp.54-55) and all, a practice that has survived to today. The plant's taproot means the plant can be extracted from the ground easily and the full length of the plant fibres is available for processing. If the stem is cut this encourages bacterial growth causing an uneven retting of the flax (Birkigt-Quentin, Busse and Schäfer, 1995, p.8). The pulled flax is set up in bundles, like little chapels, and left in the field to dry. It is not left to dry

flat on the ground, because there is a chance that retting would begin (Fasse, 1989, p.19; Kuhnert, 1920, p.75). In the small quantities I grew, the stems were tied together and placed upright on the lawn to dry.

Rippling and removing seeds

Several methods of removing seeds have survived in recorded history. The simplest recorded method was to beat the bundles of flax against a wall to remove all the seed vessels (Hagen and Tödter, 1985, pp.25-26). In my experiments, I found this method least effective as it takes longer and the seed vessels are dispersed further. This method requires no tools and is impossible to determine where or if this method was used in the Middle Ages. Threshing, used with cereals, cannot be used as a method as it damages the stems.

The second method involves knocking the seed vessels out with a wooden club, such wooden tools were used in Italy and Belgium until the last century. The clubs have a flat head with either a short handle or a longer elastic handle made from willow. The body of the club was mostly made from apple, walnut or ash (Dewilde, 1999, pp.81-82; Scheuermeier, 1956, p.233). The short handle club is worked with flax gathered in bundles on a worktop. A similar tool has been found in Novgorod/ Russia, but it cannot be determined whether or not its use was for flax working (Kolchin, 1989, pp.28, 256, Figure 4). The longer willow handle club was used by several men on flax bundles laid on a prepared floor. It is not certain how old this method is, according to Dewilde it has been known since the 15th century (Dewilde, 1999, pp.80-81). A similar tool, however, with a grooved underside for breaking the stems, is depicted in the 16th century, for example by the Flemish illuminator Simon Bening (Hansen, 1984, p.147).

The third method works by drawing the flax through a ‘Rippler’, which is a coarse comb that peels the seed vessels from the stems. This was the most common method recorded in recent history. It is the fastest method and easiest on the flax stems. A rippler can be seen in an early Egyptian wall painting, in which a worker stood behind a long wooden plank mounted at an oblique vertical angle, at the upper end are tines through which the flax was being drawn (Kaukonen, 1946, p.81). There is a photograph of a similar looking tool from Finland from 1922 (Kaukonen, 1946, p.80).

There are finds from the Middle Ages of crude wooden combs, that may have been used for rippling. For example, in Bryggen (Bergen, Norway) archaeologists have recovered wooden combs during excavations (Oye, 1988, p.29). Iron combs, set in wooden beams are apparently known from at least the High Middle Ages. The Hungarian National museum exhibited a 13th century comb excavated in the 1950s from a former medieval village. (Dewilde, 1999, p.90; Dr. Simonyi, Erika, Hungary National Museum: “The iron comb was found in the 1950' by István Méri at a medieval village (Tiszalök-Rázom).”)

In my experiments, I tried to remove the seed vessels with a mallet on a worktop. In theory this should work well but both the weight and shape was not very suitable, because the weight of the mallet means one must be very careful not to crush the seeds. My best results have been with combing the seed vessels to remove them.

Retting

Inside the plant, flax fibres are arranged in a circle around the central core of the stem. In the retting process the pectin, the so-called vegetable glue that surrounds the fibres, is dissolved by either bacteria (water retting) or by fungus (dew retting).

For dew retting the flax is laid out on fields; harvested stubble fields or mowed grassland are well suited to this. The combined effects of sun, rain and dew causes the stem to begin to decompose and become brittle. In order to achieve an even ret, the flax must either be laid so thin that the ground can still be seen, or if laid thicker must be turned from time to time. Depending on the weather, dew retting takes approximately three to five weeks. Warmer weather shortens the time, but if it is too dry, the flax must be sprinkled with water regularly as decomposition is achieved mostly by the fungal action. This method is more environmentally friendly than water retting. But it is longer and is more dependent on the weather. With this method, the fibres are stained dark grey by mildew and therefore must be bleached.

For water retting the flax bundles are completely immersed in ponds, rivers or other bodies of waters. Bacteria multiply and break down the flax. The disadvantage of this method is the the damaging effect it has on the environment, as bacteria withdraws oxygen from the water potentially killing fish. The water tends to smell very bad and is poisonous to most of crops, humans and animals (Dambroth and Seehuber, 1988, p.83; Harzheim, 1989, p.20). From the 15th century on, there were plenty of bans on letting flax ret in fishing waters (Reutter, 1979, p.16). Water retting though has the advantage of taking 7-10 days, depending on the temperature of the water and the amount of lime in it. High concentrations of lime prevent retting (Linke, 1982, p.20; Fasse, 1989, p.25; Birkigt-Quentin, Busse and Schäfer, 1995, p.9).

I used a large water tub for my experiments. An observation I had was that the batches using rain water rather than tap water achieved better results. Water retting seemed to take less time and the fibres were brighter and more uniform, than those achieved with dew retting.

For both methods of retting it is very important to end the retting at the right moment. If done correctly, the fibres can be extracted easily from the core. If however the flax is left too long, the cell walls of the fibres are damaged. In 2017 I left the flax too long on the ground, so that the pectin in between the elementary fibres decomposed into smaller pieces. On the whole, the retting experiments worked well, with even my first attempts turning out usable material despite my lack of experience. Of course, I didn’t reach the full yield, that a good ret

would deliver. With both types of retting I was unsure of when to end the process and probably never achieved the optimum result. In addition, my first attempt at dew retting was in October 2014 in Northern Germany, when it was probably already too cold with daytime temperatures around 16-18 degrees. The retting lasted about 10 days longer than in later tests in August 2015 and 2016 at temperatures between 25 and 30 degrees Celsius. You do get a feeling and understanding of the process for the retting process very quickly.

Drying

After retting, the flax is dried again. This was often done in the fields in the same way as it was after harvesting. The flax is spread out thinly and turned every day, while being dried by the sun. Again, the greatest disadvantage is dependency on the weather. If the weather is bad, it can take a very long time for the flax to dry or, in the worst case, the whole harvest is lost.

From the Middle Ages on, there is written and archaeological evidence of drying in ovens (Lipp, 1989, pp.8-9) or special drying units that differed from region to region. Bread ovens, either private or communal, could be used, although there was a high fire risk as the dry flax is highly flammable.

The simplest dryers are made from a simple pit, where the flax is laid on a gridiron over a small fire, which was also a big fire hazard.

Therefore, it was better to work with two pits. A fire was lit in one pit, and through a tunnel, smoke and heat were conducted into the other pit, above which the flax was placed on a grid to dry.

(Knöchel and Vogeler, 2001 p.109) There are over 60 archaeological finds of this type of dryer dating back until the 13th century in the Rhineland alone. Although these archaeological finds lack the evidence of plant remains to clarify what was actually dried inside (Berthold, 1999, p.131). In the Odenwald region, there is written evidence dating from the 18th century that describe these types of structures being used to dry flax (Heimberger, 1957, p.254).

The flax stems were often broken immediately after being removed from the oven, which gave them names such as “breaking pit “or “breaking” oven (Harzheim, 1989, p.21). If the temperature is too high the fibre will be damaged, which is why artificial drying was not always used.

During an event I had the chance to try out oven drying. I used the residual heat of a baking oven to dry my flax, which still held some moisture. Using this method, the flax could be extracted more easily from the bast. I can also confirm the description that the outer hull breaks like glass after the drying. It is very important however that the flax is broken directly after drying, otherwise the flax will absorb moisture from the atmosphere quickly, which is the reason why it is more difficult to break and scutch flax during days with high humidity.

The next steps of processing take place in late autumn and winter. A 13th century song from Neidhart, titled “Winterlied 8”, has a section in which the scutching of flax is mentioned (Tomasek, 1996). For the same reason, paintings of flax processing by the Nürnberg painter Albrecht Glockendon (1526 and 1535), as well the Flemish painter Simon Bening (1515) are associated with November.

Breaking

Initially the stems are worked with a wooden club or mallet, to break the woody parts of the outer hull and core. They fall off the fibres as small pieces called “shives”. In the Modern Age this is called ‘boken’. Early Egyptian wall paintings depicted this process (Schaefer, 1944, p.2264) and it was also described in writings by Pliny, the Roman scholar, but not as a preliminary step but the actual breaking process. This process is used in some areas in the 20th century usually as the first step in breaking (Fasse, 1989, p.29). There are archaeological finds of wooden clubs from Bergen (Bryggen), that could have been used in flax processing that date back to the late medieval period, as well as finds from Novgorod (Oye, 1988, p.28; Kolchin, 1989, p.256). In a 13th century text by Gottfried von Neifen on the topic of flax processing: „si kann beidiu dehsen unde swingen“ (She can do both, breaking and scutching.), Lied II, 5 1-3 (Cramer, 1998, p.187). It is not clear whether “dehsen” stands for beetling or breaking of the flax. In several depictions and woodcarvings, the earliest in 1526 by Albrecht Glockendon of Nürnberg, show flax laid on a block and a worker with a wooden club in a raised hand. It is somewhat difficult to find a fitting association. When looking at the depiction by Glockendon, it suggests that it could be either breaking or scutching, whereas other depictions show more likely a step in breaking. There are, on the other hand, other depictions from this time that show the flax breaking by other means.

I have tried to break the flax with a wooden club and it works, but restricted that to splitting the stems lengthwise and the work takes longer. If ‘boken’ is used as a preparation for breaking, then it makes the later step easier to accomplish.

At some point the flax break was invented. It consists of a large long heavy wooden block with a longitudinal groove, attached to a wooden frame. A foldable lever with an integrated V-track and handle is pushed down onto this board. When the V-track interlocks with the groove, the flax stems are broken both across their width and length. This causes a large amount of the woody outer hull to drop off.

The oldest mentions of the flax break are found in secondary literature, dating its invention to around the 13th century. The German name of “Dutch breaking chair” suggests the break being invented by the Dutch (Dewilde, 1999, p.155). The oldest depiction of a flax break is from a 15th century fresco in the parish church of Saak/ Austria, which dates to 1465. This fresco depicts Christ during a feast surrounded by tools among which a flax break can be found.

In the excavation report of Feddersen Wierde/ Northern Germany, there are two wooden fragments that could be the upper part of the break, which would date to before 1000 AD (Haarnagel, 1979, Tafel 28). There is a similar artefact that dates from the Slavic period (600 to 1200 AD) on display in the State Museum in Brandenburg/ Germany. Excavations during the building of the A20 motorway in Northern Germany, uncovered a 68 cm long wooden block with a lengthwise groove and a hole drilled through, possibly for the shaft of the lever. Ceramic analysis and radiocarbon dating gives a date of around 400 AD (Seegschneider, 2005, pp.145-146).

These finds suggest that the flax break, which have been preserved until the last century in the villages of northern Germany, date to the Early Middle Ages.

However there are no illustrations or depictions until the break becomes widespread in the Late Middle Ages. The only change over time was the addition of extra v-shaped tracks and grooves.

My flax break is a reconstruction based on the depictions of Albrecht Glockendon, in a calendar from 1526, and the fresco in Saak. Work with this break is fast and effective. A bundle of flax is placed between the upper and lower parts of the break and then struck with the upper section several times while slowly pulling the sheaf through. The sheaf is then turned and worked on the other side.

The frescos in house Zur Kunkel, Constance dating to the 14th century (Wunderlich, 1996, p.29) showed a different aspect to production of cloth. Hemp and nettle can be used to make linen like cloth and the steps for flax and hemp processing do not differ much. The frescoes in Constance illustrate hemp fibre processing with a local specialty depicted in the breaking process. On the fresco, the hemp is broken by hand, which seems to be both difficult and ineffective. However, 19th century Italian texts seem to explain the process. The fibres were pulled off the stem by hand, starting at the root and the bast was removed from each stem individually (Gerig, 1913, p.40).

Hemp unlike flax, has not only one, but several rings of fibres and much stronger stems. However, hemp has very fine fibres at the centre of the stem (Körber-Grohne, 1987, p.383). So far I have only worked on small amounts of hemp, but the process works well even though it takes longer.

Scutching

The goal of scutching is to remove the last remaining parts of the woody material from the fibrous layers. The broken stems are laid over an upright standing board, the scutching board, and then worked with a scutching knife (a flat usually narrow wooden board with a handle) to remove the shives.

There are 13th century songs about scutching. The Kunkel house fresco shows a woman who is probably scutching and labelled “Thesens”, which is somehow connected to scutching (Wunderlich, 1996, pp.53-54). However she has the flax simply lying on her thighs and a scutching knife in her hands. My experiments with this method were not very successful, though I may lack some information or just practice.

Pictures by Alfred Glokendon from 1526 depict scutching. There is a woodcut from 1580, which shows a wooden table or block, where a worker lays the flax. In the “Heidekloster Wienhausen”/ Northern Germany there are depictions of scutching on two tapestries. One tapestry dates to the end of the 14th / beginning of the 15th century and the second tapestry to 1480. The scutching boards depicted already have the shape known until the last century. The same board shape is seen in pictures by the painter Simon Bening, date to 1515.

The State Museum in Braunschweig possesses a scutching sword, dated to the 13th century, that was found in downtown Braunschweig/ Germany. It is made from beech and looks like a broadsword, which is probably where the German name for this tool originated.

We have replicated the tools from the depiction in Wienhausen and from the find in Braunschweig. Scutching, as with breaking, is very exhausting work. However the last remains of the shives can be removed effectively and the fibres loosened and aligned.

Smoothing

Another processing step, that has survived from at least the Middle Ages to the last century, but not used everywhere, is called smoothing. During smoothing, the fibres are not only aligned but also smoothed with very fine silky fibres produced (Fasse, 1989, p.37). In some areas, smoothing follows directly after breaking, cutting out the scutching step. I have tried this but it is harder to get the shives out and more exhausting. Better results are obtained by scutching the flax beforehand.

For smoothing, a piece of leather is placed on the thigh and the fibres are worked with a smoothing knife. The smoothing knife has a wooden handle, and while holding an iron sheet, whose edges are kept unsharpened so as to prevent the fibres from being damaged, the flax is laid in bundles on the leather and smoothed with a smoothing knife.

There are two depictions from the Middle Ages. Again, from House Zur Kunkel, this process is depicted and entitled as “riben” however, there is not a tool in the hands of the worker. On the 13th century carving of the northern portal of the cathedral of Chartres/ France, there are several female figures doing textile work. One woman is shown smoothing and has clearly visible a piece of leather placed on her thighs and a smoothing knife. This type of work has not changed in the last century, which is shown in a photograph taken in 1911 in Spenge/Germany (Fasse, 1989, p.37). The author sets the step of smoothing after the

hackling, which matches the depictions from the House Zur Kunkel. There seems to be different experiences, in which order the work is done.

Hackling

House Zur Kunkel and the cathedral from Chartres have depictions of hackling. The hackling comb itself has the shape that has survived to today. In the middle of a longish board, there is a round block with tightly fitted pointed nails. The flax is pulled through the comb to remove shives and short fibres. Unlike modern hackling were the comb is clamped into a light wooden frame, medieval depictions show women that have the hackling comb pressed against their knee.

For a good hold, the hackling comb has a semi-circular opening on the lower end as a toehold. A hackling comb was found in good condition in the castle of Bommersheim/ Hochtaunus, Germany, which was destroyed in 1382. This medieval comb is almost identical to a 19th century hackling comb in the author's possession.

It seems evident that many farmer tools changed very little over time until the industrial age.

There are also illustrations of hackling combs, for example a miniature from a medieval Italian transcript of Pliny's Natural History shows a very basic hackling comb. It is a board with a nail block placed on the knees (Schaefer, 1944, p.2268). There is an illumination from France, dating to the first half of 15th century, also depicting this process (British Library Royal 16 G V f. 56 Gaia Caecilia). The image shows weaving, spinning and carding of wool, but the third woman seems to be working with flax. She sits in front of a tree trunk with multiple rows of long prongs, and she is pulling long fibres through the prongs. This is unlikely to be an image of wool combs as they are normally depicted as pairs with only one or two rows.

At later dates, there are several types of hackling combs. A pull-out hackling comb, which was very coarse was used for pulling out the branched flower stems, something that isn't done everywhere. There were coarse and fine hackling combs used in succession to receive very fine and long fibres. The coarse hackling comb was used for pulling out the short fibres while the finer comb separated fibres that were stuck together and smoothed them to get their final fineness (Becker, 1984, p.8; Schmitz, 1975, pp.9-11).

The short fibres combed are called tow and can be carded by hand and spun as well. As yet the author has only found modern descriptions of tow processing (Siuts, 1982, p.156).

In terms of yield, this should be about 10-15% of weight of the dried plant left as long fibres (Dambroth and Seehuber, 1988, p.87; Schilling, 1935, p.33; Flad, 1984, p.24). In my initial experiments, the yield probably was significantly lower, but should still be viewed as successful given the lack of experience. In the future, I would like to start here in order to

achieve even better results and determine by measurements how much fibre yield I can achieve with the knowledge of flax processing that I have acquired myself.

Conclusion

This is only a short overview on flax fibre extraction in the Middle Ages. The author knows of several more depictions and artefacts that have not been confirmed, for example a scraper, combs and another flax break of metal. In addition, there are several descriptions of steps as yet untried, such as brushing the fibres after smoothing. Greater access to tools will help the experiments get closer to flax fibre extraction operations from the Middle Ages. The methods used in processing differed from area to area and not every step is present everywhere. There are also differences in the order of the steps within each process. The research for this project was able to trace a lot of pre-industrial tools to the Middle Ages and even prior to this time. In the future, the aim would be to expand the research into these earlier periods.

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FIG 1. END OF APRIL, TEN DAYS AFTER THE SOWING, THE FLAX BEGINS TO SPROUT. PHOTO BY MARTINA KÖNIG.

FIG 2. EARLY JULY, THE FLAX IS IN FULL BLOOM. PHOTO BY MARTINA KÖNIG.

FIG 3. MID JULY, PULLING FLAX. PHOTO BY MARTINA KÖNIG.

FIG 4. LETTING THE PLANTS DRY. PHOTO BY MARTINA KÖNIG.

FIG 5. REMOVING SEED VESSELS WITH A WOODEN CLUB. PHOTO BY MARTINA KÖNIG.

FIG 6. REMOVING SEED VESSELS THROUGH RIPPLING. PHOTO BY MARTINA KÖNIG.

FIG 7. RETTING ON THE GROUND. PHOTO BY MARTINA KÖNIG.

FIG 8. RETTING IN WATER. PHOTO BY MARTINA KÖNIG.

FIG 9. FLAX THAT WAS RETTED ON GROUND AND IN WATER. PHOTO BY MARTINA KÖNIG.

FIG 10. KILN DRYING, THE FLAX IS DRIED IN THE RESIDUAL HEAT OF A KILN. PHOTO BY MARTINA KÖNIG.

FIG 11. BREAKING FLAX STEMS WITH A WOODEN CLUB. PHOTO BY MARTINA KÖNIG.

FIG 12. BREAKING THE FIBRES WITH A FLAX BRAKE. PHOTO BY MARTINA KÖNIG.

FIG 13. SCUTCHING THE FLAX FIBRES. PHOTO BY MARTINA KÖNIG.

FIG 14. SCUTCHING KNIFE. PHOTO BY MARTINA KÖNIG.

FIG 15. USING A SMOOTHING KNIFE ON THE FIBRES. PHOTO BY MARTINA KÖNIG.

FIG 16. HACKLING THE FLAX FIBRE. PHOTO BY MARTINA KÖNIG.

FIG 17. FAILURE. THE FLAX HAD BEEN RETTING FOR TOO LONG. THEREFORE THE LONG FIBRES HAVE DISSOLVED PARTIALLY. PHOTO BY MARTINA KÖNIG.

FIG 18. THE FINISHED WATER RETTED FLAX FIBRES, WHICH BECAME SUPER FINE BECAUSE OF AN EARLY HARVEST. PHOTO BY MARTINA KÖNIG.