The use of local fibres for textiles at Neolithic Çatalhöyük (Turkey)

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This article focuses on the fibre analysis of the textiles found in Çatalhöyük. The earliest known woven textiles were discovered at this site, and the fibre has shown to be oak bast in at least one case. As fibres from other early sites have also proved to be tree bast, the date of the first use of domesticated flax is called into question, as well as the proposed import of flax. Instead the fibres chosen appear to be local plants. The results offer a new explanation for the lack of flax seeds in the settlement and give another view on the domestication of plants and the „chaîne opératoire" of textile production.

Keywords: Neolithic, Çatalhöyük, textiles, weaving, plant fibres, tree bast, flax

INTRODUCTION

The archaeological site of Çatalhöyük is located in southern Anatolia and consists of two mounds, Çatalhöyük East which is Neolithic and Çatalhöyük West which is mainly dated to the Chalcolithic period. During the Neolithic, a tributary of the Çarsamba river intersected the two mounds and created a system of channels and islands with different landscape types (Ayala & Wainwright 2020). The tell site is very large (about 13ha); there are nearly 21m representing deposits of about 1150 years of continuous occupation by a complex society with a rich material culture (including e.g. wall paintings, figurines, graves with skeletal remains, stratified occupation in houses, early ceramics). The first excavations took place between 1961–1965 (Mellaart 1967). In 1993 excavations were resumed, first at the East mound by the Çatalhöyük Research Project, directed by Ian Hodder, later also at the West mound (Hodder 2014; Hodder & Kutlu in press; www.catalhoyuk.com). During both excavation campaigns, numerous objects of perishable materials such as cordage, basketry, matting and textiles were discovered. These textiles and cords were used in burials to wrap the deceased in a flexed position. Baskets were also used in burials, in particular to inter babies, but occurred in other contexts too. Mats were used e.g. for floor coverings (Helbæk 1963). Due to poor conditions of preservation generally, little is known about early textiles and cordage and the fibres they were made from. The fibres from Çatalhöyük have long been a matter of contention: they have been identified as flax as well as wool. Since then, awareness has been raised

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of tree bast fibres used for string, netting and textiles. Such fibres are well documented from Neolithic Europe (Rast-Eicher 2005; 2018). Depending on the location of the bast layers in the bark – inner layers closer to the wood or outer layers – these fibres can be very fine and resemble flax fibres morphologically, for instance showing similar diameters. Cordage and strings are usually made of tree bast, mostly of willow, oak or lime; but lime bast was also used for woven textiles (Rast-Eicher & Dietrich 2015). This new knowledge made it especially important to investigate and re-investigate the textiles and fibres from Çatalhöyük. Recent discussion about the textile fibres of Çatalhöyük and other early sites of the Near East such as Wadi Murabba'at and Nahal Hemar in Israel is focused on flax, whether it was domesticated or not, and potentially traded (Bar-Yosef 2020; Fuller et al 2014; Shamir & Rast-Eicher 2020).. The use of tree basts - that involve a completely different châine opératoire – was not considered althougwell known from Mesolithic and Neolithic Europe.

The age of the textiles from Çatalhöyük

The textiles found during the Mellaart excavations derive from Level E VI A/B, then dated between 6200 and 5800 BC (Mellaart 1964, 116). Since then radiocarbon dating methods have developed substantially. The chronology of the Çatalhöyük East site is now based on Bayesian chronological modelling, starting ca. 7100 cal BC (Bayliss *et al.* 2015; Hodder & Kutlu in press). Four habitation phases have been defined: an early phase (7100–6700 cal BC), a middle phase (6700–6500 cal BC), a late phase (6500–6300 cal BC) and a final phase (6300–5950 cal BC). This is a correction and refinement of earlier published dates (Cessford *et al.* 2005; Hodder 2014). The textile finds from the Mellaart as well as the Hodder excavations all derive from the middle phase (Hodder & Kutlu in press, Table 1.2). This means that they date to between 6700 and 6500 cal BC, a narrower time span than the previously suggested 6700–6300 cal BC (Bayliss & Tung 2017; Rast-Eicher & Bender Jørgensen 2018).

Textile fibres at Çatalhöyük

The first textiles were discovered in 1962. They were excavated by palaeoethnobotanist Hans Helbæk (Helbæk 1963). Helbæk emphasized that he was no textile expert and refrained from describing the textiles in detail except for the fibres. Apart from one piece of a string, he stated that all other textiles were made of animal fibres, probably wool (Helbæk 1963, 43–44). In 1963 the textile historian Harold B. Burnham examined the textiles (Burnham 1965). He accepted Helbæk's fibre identifications. Wool specialist Michael L. Ryder, however, did not accept Helbæk's determination and stated that some of the textiles were made of flax (Ryder 1965). Textile specialist Gillian Vogelsang-Eastwood confirmed the identification as bast fibres, probably flax (Vogelsang-Eastwood 1988). In 2013, textile remains from building 52 were determined as having been made from domesticated flax (Fuller *et al.* 2014). James Mellaart never accepted that the textile fibres from Çatalhöyük were not wool (Mellaart 1967, 219). The arguments for wool fibres were the presence

of nitrogen in the fibres, the absence of flax seeds at the site, and the finds of sheep bones and ram skulls (Burnham 1965, 170, quoting Mellaart 1962, 56 and 1964, 57, 66, 73). Recent excavations (Bogaard *et al.* 2013, 98, 128; Bogaard *et al.* 2017, 3, table 3; Filipović 2014, 57, 59) have confirmed the near-absence of flax seeds by finding only a small quantity. According to Bogaard *et al.* (2013) linseeds are absent from the mid-later Neolithic layers but occur at low levels in the earlier Neolithic sequence. Filipović (2014, table 4.5) lists in total 13 seeds of *Linum* spec.
For the Hodder excavations, Willeke Wendrich and Philippa Ryan examined basketry and matting (Wendrich 2005, Wendrich & Ryan 2012), Antoinette Rast-Eicher and Lise Bender Jørgensen analysed textiles and cordage (Bender Jørgensen & Rast-Eicher 2017; Rast-Eicher & Bender Jørgensen 2018; Bender Jørgensen *et al.* in press).

Textile production in the Neolithic

Plant fibres were used for a multitude of purposes in the Neolithic, including thin, flexible fabrics in techniques such as twining and weaving. Threads for such fabrics were made by splicing (Leuzinger & Rast-Eicher 2011; Gleba & Harris 2018); they were not retted and spun as in later periods. Instead, strips of fibres were added to one another by rolling them together by hand. Two such yarns were then plied. Fine threads from Neolithic Europe and the Near East are always plied. The technique probably derives from early string production using tree bast.
Twining is a very important technique in the Neolithic to produce flexible fabrics (Alfaro 2012; Schick 1988); weaving marks a further development of this earlier technique (Bender Jørgensen *et al.* in press). All woven textiles from the Neolithic are made in simple tabby or plain-weave.

MATERIAL AND METHODS

17 textiles (woven and twined) and 14 thread/strings made of plant fibres were recorded from the Neolithic layers in the East mound of Çatalhöyük (Bender Jørgensen *et al.* in press).
A small selection of samples for fibre analysis was made on site (we were advised to take as few and as small samples as possible, so that the Turkish administration would allow them to be analysed outside Turkey; Tab. 1). One was taken from a coiled basket (no 20465) to check the stitching; the coils are mineralised and material identification was based on their siliceous remains (tab. 1, sample 2; Wendrich & Ryan 2012). Four samples were taken from cordage or textiles (tab. 1, samples 4, 9, 15 and 11). In addition, a sample was taken from a textile fragment from the Mellaart excavations now at the Textile Research Centre in Leiden (tab. 1, last line). The box containing the latter is labelled ‘Textile from skull, lower layer VI’. As this sample is dated ‘Summer 1963’ it may derive from the textile described as found in Room E VI,1 (Mellaart 1964, 93; Pl. XXIV a, b; Mellaart 1967, Pl 94). The samples are mostly charred; when the house burnt, the plant material in graves under the floors was ‘baked’. This is the reason the textiles were preserved.

The samples were mounted in the laboratory on aluminium stubs, which were then sputtered with gold (about 20vm). They were then analysed with the help of a scanning electron microscope (SEM) (Zeiss EVO 50, 15KV; SEM of the University of Bern, Switzerland, Institute of Geography, Oeschger centre, analyses A. Rast-Eicher). The results were compared with findings of bast fibres from previous work (Rast-Eicher 2016a, b; Rast-Eicher & Dietrich 2015).

The identification of archaeological plant fibres is a challenge. The main characteristics of bast fibres (to which both flax and tree bast belong) are the nodes. Although bast fibres share the main characteristic – the presence of nodes – there are important differences between the families; a range of characteristics have to be checked: the fibre diameter, the presence or absence of epidermis or rays with clear morphology, presence and form of crystals and stomata cells, form of the fibres seen in the cross-section, form and diameter of the lumen (inner canal of fibre), and twist of the cuticula. Flax has no rays and no large perforated vessels. In order to enhance comparisons, modern reference material (fresh and experimentally charred) was also prepared for cross-sectioning. Cross-sections were made with a microtome (HM 355S Thermo Fisher Scientific) and photographed with a Leica DM 5000B photo-microscope (Botanical Institute of the University Potsdam (Germany), preparations and photographs: Barbara Schmitz and Sabine Karg).

Catal sample/no for SEM	No	Technique	Building/layer	Fibre
sample 2; SEM18/13	20465	coiled basketry	space 489	mostly preserved as silicified structure/phytholiths; stitch: Gramineae leaf
sample 4; 18/10	30511, s4	cordage	building 52	charred; plant fibre, oak bast
sample 9; SEM18/3	17457 X10	woven; tabby	building 49	mineralised; badly preserved, with conservation product, fibre dm. 7-15um, plant fibre
sample 11; SEM17/229	30503 s8	woven; tabby	building 52	charred; badly preserved, cross-section with hollow fibres, remains of ray, oak bast.
sample 15: SEM17/230 sample 16: SEM18/11	22661 s5	net? tassel?	building 131	charred; plant fibre with large lumen, dense fibre bundles, ev. rays, dm. differences, tree bast fibre?

Leiden sample; SEM 17/209	1963 Textile from skull	woven; tabby	Mellaart VI A/B	charred; polygonal fibres, some thick & crossing nodes, large lumen, unclear (tree bast?).

Tab. 1. Catalhöyük. Samples dated to the Neolithic Period (6700–6500 calBC).

RESULTS

The basketry sample (sample 2) taken from the stitching is made of grass leaves (Gramineae sp.; fig. 1). The cordage (sample 4) from building 52 (no 30511-s4) is oak tree bast (*Quercus* sp.). There is a large vessel with partly perforated cell walls characteristic of oak visible on the right; on the left fibres and single-row rays can be seen (crystals missing, empty cells visible) (fig. 2a). The fibres seen in the cross-section are hollow (diameter of 5–7µm) (fig. 2b). Oak bast was also identified in sample 11 (30503 s6-9) from the same building. This sample was taken from a tabby-woven textile (fig. 3). Twined and woven textiles are flexible objects and need well-prepared fibres. Threads from Çatalhöyük textiles were spliced, the fibres used as strips. That is why remains of epidermis, or as in sample 11 remains of a large vessel, can still be seen (fig. 4a). The textile 30503 s6-9 was found in the thorax region of the infant 30511-s6. The sampled cordage (30511-s4) was wrapped around the legs. The perforated vessel of the textile sample on the right side of the photo appears as a crunched-up small fragment. This and the cordage sample show a large lumen in the cross section (fig. 4b). Textile 30503 s6-9 is the same textile that Fuller *et al.* (2014) identified as made from domesticated flax. In order to confirm our identification the morphological characteristics have been compared with modern material (fig. 5). The perforation of the vessels seen in the fibres at Çatalhöyük are consistent with oak bast (fig. 5a); the cross section of wild flax shows a small lumen (the same as well for domesticated flax, dot in the centre) (fig. 5b); the oak bast has a large lumen (big black space on fig. 5c). The large lumen is therefore important for distinguishing flax from oak bast.

The woven textile from building 49 (sample 4, 17457 X10) has been made of spliced fibre bundles, unfortunately not easily visible and probably covered by conservation products. No further details can be made out, so that 'plant fibres' remains as the appropriate identification term.

Samples 15 and 16 belong to a net or tassels of a textile found in building 131. The threads are 3-ply and made with large fibre strips. The cross-section shows large differences in the fibre diameters, thick-walled fibres with a very large lumen, but not as large as the oak bast fibres (fig. 6). The large bast strip shows an unusually large lumen dimension for flax.

The Leiden sample shows quite a large lumen, not as large as those from the samples identified as oak bast (sample 4 and sample 11) from building 52, but larger than is usual in flax (fig. 7). The

cell walls are thick and the lumen generally large – too large for flax. No other morphological details such as epidermis or rays are visible: the determination therefore is not clear.

DISCUSSION

This is the first time it has been possible to prove that tree bast, in this case from oak, was used for the production of cordage and woven textiles at Çatalhöyük, and indeed in the Neolithic. The textile first published as flax is in fact a made from oak bast fibres.

Charcoal and woodcraft analyses from Çatalhöyük show that oak was the most common wood species, used for timber and fuel; Asouti (2005, 240-243, 248-254) argues that oak grew within a 10 km distance from Çatalhöyük and that timbers were floated down the Çarsamba river following woodcutting trips in the spring. It means that oak was available locally.

It is often overlooked that tree bast was the earliest processed plant material; in the search for early flax fibres has dominated the discussion. A find from Georgia has been claimed as the earliest use of wild flax for fibre production (Kvavadze *et al.* 2009); this has been refuted as the fibre diameters are far too large for flax (Bergfjord *et al.* 2010). Another find thought to be flax was a fine S-plied thread used as binding to fix a wooden comb found in Wadi Mubarra'at (Israel, Jordan valley) and dated to 9500 cal. BC (Schick 1995). New analyses of the string clearly prove fibres of tree bast with remains of rays (Shamir & Rast-Eicher 2020, 34-35). A woven textile from Ilıpınar (Turkey) phase X dated to 6000 cal BC (Roodenberg & Roodenberg 2008, 6, Fig. 14b) can be added to these. The fibres display untypical structures for flax such as remains of a perforated vessel (perforations and side wall of the vessel), and it can be concluded that the textile was made of tree bast (Rast-Eicher 2019).

The large corpus of Neolithic textiles from lake dwellings in Europe include a large textile with knotted pile and woven of lime bast, found in Zürich (Zürich-Mythenschloss; Rast-Eicher & Dietrich 2015, cat. no 1001, Taf. 106, 107); it is dated to the Corded Ware Period (2750 BC, dendrochronological date). The fibre strips are quite large and fine rays still visible (fig. 8). The dimensions of the fibres are similar to those of flax fibres. A spindle found in Arbon (Switzerland) wound with lime bast yarn is dated ca. 3400BC; De Capitani *et al.* 2002).

Early textiles made of plant fibres are rarely preserved in archaeological layers. In the Southern Levant, strings made of grasses (monocotyledons) have been identified from Ohalo II, a hunter-gatherer camp dated to 19,300 BP (Nadel *et al.* 1994). From the early Neolithic period onwards, preserved twined textiles are reported from sites dated to the 9th and/or to the 8th millennium cal BC such as Tell Aswad and Tell Halula in Syria, Nahal Hemar in Israel and Çayönü in Turkey. They are reported as of flax or possibly flax (Alfaro 2012; Schick 1988; Stordeur *et al.* 2010; Vogelsang-Eastwood 1993).

Imprints of woven textiles have been found at Jarmo in Iraq (7,000–6,000 cal BC) and El Kown 2 in Syria (7,100–6,000 cal BC); further imprints from Tell Kashkashok in Syria, and Telul eth Thalathat

and Tell es-Sawwan in Iraq are all dated to the second half or the end of the 7th millennium cal BC (Bender Jørgensen *et al.* in press with further references). It means that the textile remains from Çatalhöyük represent the earliest preserved woven textiles; together with the imprints from Jarmo and El Kown 2 they currently form the earliest evidence of weaving (Bender Jørgensen *et al.* in press). The only other preserved woven textile from the 7th millennium BC is from Ulucak Höyük and dated 6,500–6,000 cal. BC (Çilingiroğlu 2009). In the case of the imprints, no fibre identification is possible. No fibre identification of the textile from Ulucak Höyük has been reported. As we have seen, the woven textile from Ilıpınar was made of tree bast.

Flax Beginnings

The early history of flax domestication is still being explored. The progenitor of domesticated flax (*Linum usitatissimum* L.) is *Linum bienne* Mill. (= *Linum angustifolium* Huds.; Diederichsen & Hammer 1995). This plant occurs widely in the Near East and Mediterranean area (Zohary *et al.* 2012). The preferred habitat includes areas of highly moisture, which have been attested for the vicinity of Çatalhöyük (Ayala & Wainwright 2020). Only a very few flax seeds were found in the Neolithic layers of the site. In view of their small size, they were identified as most probably deriving from wild flax (Fairbairn *et al.* 2005, 174; Filipović 2014, 35 and personal information from Filipović 18.09.2019). Systematic seed measurements of modern flax varieties, as well as wild flax point to a clear metric difference (Karg *et al.* 2018). As there is no evidence of domesticated flax at Çatalhöyük, we can advance the hypothesis that wild flax was collected in the surroundings of the settlement for probably two purposes: the use of the oil-rich seeds for nutrition and the stems for fibre production.

The making of woven textiles was probably a small-scale activity, following the hunter-gatherer tradition of exploiting wild plants for their fibres. The raw material was available in the surroundings of the site. Tree bast was harvested in springtime when the sap is rising within the tree trunks, which facilitates the removal of the bark with the attached bast. This would also be the case with wild flax: the bast stripes still contain water and are easy to splice when taken from green stems (Leuzinger & Rast-Eicher 2011). Based on the analyses of the phytoliths from the baskets, the grasses (e.g. reed) were also collected in spring (Wolfhagen *et al*. 2020, 101).

Conclusions

The discovery that several Çatalhöyük textiles, the string from Wadi Murabba'at and the Ilıpınar textile were all made of tree bast fibres demonstrates that the resource played an important role in the early history of textiles, and raises new questions regarding the identification of flax fibres at other early sites. The results show a similar development as in Neolithic Europe, where the use of tree bast fibres was common, even for woven textiles. We may conclude that the inhabitants of Çatalhöyük had a profound knowledge of the fibre properties of bast from oak, and probably other trees, as well as wild flax. The environmental conditions around the settlement were

suitable for harvesting different raw materials in the close vicinity and there was no need for import of textile fibres. Collecting raw material for baskets and textiles would have been part of the inhabitants' activities during springtime, perhaps combined with the procurement of timbers. The exact identification of raw material in textiles can set light on the interpretation of plant domestication and plant use in Neolithic context.

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Captions

Fig. 1. Çatalhöyük no 20465. Fibres of stitching in coiled basketry, grass leaf. Photo A. Rast-Eicher.

Fig. 2. Çatalhöyük no 30511-S4. Cordage, a) remains of oak bast with fibres and a large perforated vessel, b) Cross section with thick cell walls. Photo A. Rast-Eicher.

Fig. 3. Çatalhöyük no 30503. Tabby woven fragment. Photo A. Rast-Eicher

Fig. 4. Çatalhöyük no 30503-s8. Woven textile, a) fibres of oak bast with remains of perforated vessel (arrows), b) cross section with thick fibre walls and big lumen. Photo A. Rast-Eicher.

Fig. 5. Comparison material. a) Oak bast. b) Cross section of *Linum bienne*, charred. c) Cross section of oak bast, charred, with large lumen of fibres (arrow). Photos a&b A. Rast-Eicher; c) B. Schmitz & S. Karg.

Fig. 6. Çatalhöyük no 22661-s5 from building 131. Thicked-walled plant fibres with relatively large lumen. Photo A. Rast-Eicher.

Fig. 7. Çatalhöyük, sample from Leiden, Mellaart excavation, plant fibre with very large lumen. Photo A. Rast-Eicher.

Fig. 8. Zürich-Mythenschloss (Switzerland), no 1375. Thread of tabby woven textile made of lime bast (*Tilia sp.).* Photo A. Rast-Eicher.