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## POST-HARVESTING PROCESSING OF HULLED WHEATS. AN ETHNOARCHAEOLOGICAL APPROACH.

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**Abstract:** Ethnographic research carried out in different areas of Spain and Morocco where hulled wheats are still cultivated under traditional methods, has allowed to study the range of operations involved in their processing. This paper focuses on some post-harvest procedures, e.g. threshing, parching and dehulling. The controversial issue of parching is analyzed in detailed through the examination of both literary sources and ethnographic evidence.

### Résumé

### Introduction:

Scattered across Europe, areas of Africa and the Near East, small pockets of traditional cultivation of hulled wheats still survive. These rural communities, often isolated in mountain areas, represent the last examples of a way of life already about to disappear. Despite the general trend towards standardization, the spread of modern technologies, and the strong pressure to grow more productive and homogeneous crop varieties, farmers from these areas have kept cultivating their old varieties preserved in traditional agroecosystems. These areas are, therefore, an invaluable source of knowledge for traditional agricultural techniques and methods.

Over the past decade, we have been studying different aspects of the cultivation of hulled wheats, still cultivated in mountain areas of Spain and northern Morocco (González Urquijo, González Vázquez, Ibáñez Estévez, Moreno García, Peña-Chocarro, Ruiz Idarraga, Zapata Peña & Gómez Pellón, 2001; Ibáñez Estévez, González Urquijo, Peña-Chocarro, Zapata & Beugnier, 2001; Peña-Chocarro, 1994, 1996, 1999; Peña-Chocarro & Zapata Peña, 1997, 1998; Peña-Chocarro, Zapata, González Urquijo & Ibáñez Estévez, 2000). The species involved are einkorn (*Triticum monococcum* L.), emmer (*T. dicoccum* (Schrank) Schübl), and spelt (*T. spelta* L.).

The main objectives of our research have been to document the agrarian cycles of these three species with particular emphasis on the different steps and operations of the crop-processing sequence. Diversity in techniques, agronomic practices and uses of these crops have been also part of our goals. Through these aims we have attempted to throw some light on prehistoric agriculture.

In this paper, we will present data on some of the post-harvesting operations involved in processing hulled wheats, paying particular attention to threshing, parching and dehulling

methods. The reason is twofold: a) these show a certain range of technical variability, and b) parching and dehushing are essentially related to hulled wheats technology.

Apart from our own ethnographic data, we have also refer to other ethnographic accounts as well as literary sources.

### **Location of the study areas**

The areas under research are situated in Spain and northern Morocco (fig. 1). In Spain we have focused in three main regions: three provinces of Andalucía (Córdoba, Jaén and Cádiz) situated in southern Spain, and two regions of northern Spain (Asturias and Navarra. In Morocco, our field work has developed in the western Rif mountains (north of the country), in the region of Jebala, close to the city of Chefchaouen.

As far as climate and vegetation are concerned, southern Spain and northern Morocco show a clear Mediterranean character. Agriculture and animal husbandry are the main economic activities. Arable crops include mainly wheat and barley (maize and sorghum should be added in the case of Morocco) and legumes. Olive growing is another characteristic of the landscape, which in Andalucía has occupied most of the arable land becoming a proper monocropping system with enormous financial return. Domestic animals include cattle, sheep, goats, donkeys, mules and hens.

Asturias lies at the north western part of the Iberian Peninsula. The area of our interest is situated at the south part of the territory, occupied by a massive range of mountains. This particular situation originates a very dissected topography. As far as climate is concerned, Asturias can be defined as an Atlantic zone with a characteristic humid mountain climate. Livestock and mining have been the main economic activities of the region, whereas agriculture is just a complement, and practised at small scale. Potatoes, maize, emmer and spelt and a few legumes (beans and peas) together with summer crops the main elements of the agrarian production.

In all cases, hulled wheats are cultivated in marginal areas, and most of the production is used for household consumption, although a part may be sold at the local markets.

### **Crop processing**

Although a great amount of work is put into pre-harvest operations (preparation of fields, clod breaking, sowing, weeding), the bulk of the agrarian work starts with harvesting and crop processing. In many cases, a large part of the processing (threshing, winnowing, sieving) is done immediately after the harvest, and before they are put into storage in a semi-cleaned form. The remaining phases of the processing (dehushing and different steps of grain cleaning) take place at small scale on daily basis.

#### *Threshing*

The methods used for threshing hulled wheats are identical as those used for the free-threshing wheats. The difference is on the resulting product; whereas in free-threshing wheats the grain separates from the chaff, in hulled wheats, threshing breaks the ear into spikelets, and the grain remains inside its husks, being necessary a further operation to free it from the chaff.

In areas of hot and dry summers such as the Mediterranean region, threshing is carried out outdoors, in threshing yards generally located near the villages or the farmer's fields. This is the case of Andalucía and northern Morocco. On the contrary, in Atlantic areas, such as Asturias, characterized by rather wet summers, part of the processing of hulled wheats (emmer and spelt) could take place indoors, or at least in a place away from rain. In this way, it is worth noting that threshing was, in some areas, carried out underneath the aerial granaries widely spread in the region.

Different techniques have been documented:

- a) Use of threshing sledges. In Andalucía, the need of finely chopped straw for animal fodder determines the use of threshing sledges for processing einkorn. Threshing sledges can be fitted with toothed metal discs, rollers, iron nails, or flint teeth. It is worth noting that farmers avoid the use of threshing sledges for einkorn unless

necessary, since spikelets tend to get stuck together and, therefore, the whole operation takes longer. This method was also practiced in Navarra (north of Spain), where summers are not so wet, for threshing emmer for animal food.

- b) Animal trampling. This is the most common method used for threshing einkorn Spain, and the only one documented in northern Morocco. A single animal, or a pair or several pairs of animals (mules, donkeys or cows) are driven in circles over the crop until the whole crop is well threshed (fig. 2). Although it is rarely practised nowadays, animals were shod before the period of threshing. Trampling but this time by humans is one of the methods documented in the most eastern part of Asturias, where the people involved used to perform a sort of rhythmic "dance" while breaking the ears into spikelets.
- c) Beating. This was and still is the most widespread technique for threshing hulled wheats in Asturias. Two different tools can be used: flails and wooden mallets known as "mazos" or "porros" (fig. 3). The mallet is a piece of wood of quadrangular shape with a carved lower surface, attached to an angled handle, which allows the crop to be beaten more easily. Farmers of this area do not seem to have knowledge of threshing sledges or other threshing techniques. Nowadays, this practice is almost disappeared due to the technical improvements carried out in the water-powered mills used for dehusking. These developments allow to feed the dehusking mill with whole unbroken ears instead of spikelets.

Although the use of flails is commonly associated to areas of wet climates, particularly in central and northwestern Europe, it is worth stressing that such technique can be equally used in dry areas for different reasons:

- In absence of threshing animals, poor families may use beating as a way of threshing small quantities of crops. This is the case recorded in by Hillman (1984b) for the Near East and South Arabia.
- Beating with different kinds of tools (wooden hammers, sticks) is also a pre-threshing operation carried out by Rifian farmers. The objective is to separate the einkorn ears from the culms, without damaging the straw. It is worth stressing that straw is a very valuable product within the rural economy of the area, and every care is taken to obtain good quality culms. For that, whole sheaves are beaten with sticks or lashed against a rock or a trunk so, einkorn ears having a semi-brittle rachis, break at their bases, getting separated from the straw (figs. 4 and 5). Immediately after, ears are threshed by trampling. The same method was used in the past throughout in Andalucía, whenever straw was used for thatching or weaving. These activities required culms in all their lengths.

Threshing is followed by a series of different steps, eg. winnowing, raking, sieving etc., that can be repeated several times until spikelets are semi-cleaned (for a fully description see Peña-Chocarro, 1999). At this point semicleaned spikelets are put into storage. Further processing (dehusking and related operations) takes place on small scale basis, according to the particular needs of every household.

## **Parching**

Throughout the literature on hulled wheats, it is often mentioned that parching is a necessary operation carried out before dehusking, in order to render the chaff brittle and make pounding easier. This idea has been widely accepted amongst archaeologists and archaeobotanists leading, sometimes, to the interpretation of charred assemblages as a result of parching activities.

In approaching the issue of parching, one of the first problems we come across is the definition of the term itself. Nesbitt & Samuel (1996) point out that parching is a type of cooking that implies a structural transformation of the chaff and sometimes of the grain as well. Drying, on the contrary, does not involve any structural transformation of the chaff. Based on experimental work by Lüning and Meurers-Balke (1980), it is suggested that temperatures up to 100°C refer to drying, whereas over 150°C it is possible to talk of parching (Nesbitt & Samuel, 1996). Nevertheless, the ethnographic literature is full of examples of the

difficulty to understand what authors actually mean when they discuss parching, i.e. roasting, drying, etc..

Many of the assumptions about parching seem to originate from a) the interpretation of Classical sources, and b) from some operations observed in ethnographic contexts which involve the use of heat.

a) The three authors most commonly quoted are Varro, Pliny and Ovid. Varro (116-27 B.C.), is the first to recall the parching of emmer, explaining that during the winter, emmer, stored in ears, should be taken to the mill to be pounded and parched (Res Rusticae 1. 53). Later, he suggests that emmer for food has to be transported to the mill for roasting (Res Rusticae 1. 59). It should be noted that, in the first passage, he mentions pounding first and parching second, implying that emmer came in contact with fire after pounding. Varro's second statement does not explain either what the aim of roasting was.

A century later Pliny (Historia Naturalis 18. 7-8) records the roasting of emmer for the Feast of Ovens (the Fornacalia). This time, though, there is an indication about a reason for roasting as emmer was more wholesome when roasted. This statement suggests that population taste preferences may influence a particular practice. Again, Pliny (Historia Naturalis 18. 97-98) records that in Etruria emmer was pounded after it had been roasted. In such a scenario, he describes the method suggested by Mago of steeping the wheat in water before pounding, then shelling the spikelets, drying them in the sun and, finally, pounding them in a mortar. This method has been tested by D. Samuel (1994) in her experimental reconstruction of ancient Egyptian emmer processing. She has shown that dampening the spikelets facilitates pounding, at least when shallow mortars are used, whereas experiments with tall, narrow mortars did not require dampening. In Egypt, drying of the damp mixture was easily carried out outdoors, however, sundrying may have been difficult in wet areas. Thus, farmers may have been obliged to use fire, which, perhaps, explains Varro's text.

The use of emmer has been also recorded several times by another classical author, Ovid (43-17 BC). What is more, he recalls (Fasti I. 690) that emmer "shall bear twice the fire" although he does not give any further explanation. In Book II of the Fasti, he described the roasting of emmer indicating the danger of crop losses due to fire. As noted in other authors' descriptions, no explanation is given for this operation but his description reminds very much of the kind of operation performed by Asturian farmers to remove of the awns (see below).

b) A second line of evidence is the ethnographic record. Our own research, in different geographic areas, where hulled wheats are/were used in various ways (human versus animal consumption), show that parching is, at least within living memory, unknown for the farmers. This is particularly interesting in the case of northern Morocco, where ancient techniques, practices have been preserved, and where einkorn is still used for human consumption.

On the other hand, it seems that much of the ethnographic evidence suggests that there is a wide range of factors that can explain the heating of hulled wheats during the crop processing. Most of them are not concerned with glume brittleness at all (see examples in Bennet & Elton, 1898; Fenton, 1978, 1991; Hillman, 1981, 1982, 1984a, 1984b, 1985; Toffin, 1983; Körber-Grohne, 1987; Peña-Chocarro, 1994). More precise information is offered by experimental work on kiln-drying/parching of hulled-wheats prior to dehusking. Meurers-Balke & Lüning's experiments (1992) have shown that previous parching produced very little effect on dehusking.

Putting all this together, it seems that parching may not have been such a common practice. However, both literary sources and ethnographic accounts include a heating at some point of the processing sequence. What does this mean?

We can start by examining some of the ethnographic accounts of crop processing from those rural communities where this operation is/was practised. The analysis suggests that the objectives of heating are/were related to various factors depending on: a), environmental conditions, b) cultural preferences, or c) technical factors (for a detailed account see Peña-Chocarro, 1999). It should be stressed that this classification is based on previous work by G. Hillman (1982) and M. van der Veen (1989).

*Environmental conditions:* in large areas on north western Europe, where summers are short and wet, harvesting may take place when the crop is not yet completely ripen, or while it is wet due to summer rainfalls. In these cases, the grain needs to be dried out prior to bulk storage in order to prevent germination or insect attack. Descriptions of different systems, eg. pot and net-drying, are available for areas of Scotland and Ireland (Bennet & Elton, 1898; Fenton, 1978, 1991, 1992). For the Faroe Islands, Hillman (1982) mentions the use of kilns for drying sheaves, and the same is recorded in Iceland for lyme-grass corn (Gudmunsson, 1991). Another example comes from Asturias, where, until very recently, farmers dried ears of emmer and spelt on perforated wooden boards. This was done immediately after harvest and before further processing. The same practice existed in Norway (Fenton, 1991), and in Nepal for wheat and barley ears (Toffin, 1983). Finally, van der Veen (1989) provides numerous examples of corn drying and malt production where permeable surfaces made in different materials (straw, wood, iron, etc..) were used to dry the grain

*Cultural preferences.* Roasting grain (both hulled and free-threshing wheats) at different ripening stages, for human consumption, seems to have been a common practice amongst traditional farmers. Examples of this, coming from different geographic areas, are common: Turkey (Hillman, 1981, 1982, 1985), Slovakia (Markus, 1989), Germany (Körbe-Grohne, 1989; Maurizio, 1927 and Hegi, 1909, both cited by Hillman, 1982, 1985; Sigaut, 1989). For naked wheats, there are several references especially from central and northern Europe and from the Near East: for rye (Treichel, 1885; Gunda 1983), and for oats (Bennett and Elton, 1898 and Fenton, 1978, 1991, 1992) amongst others.

*Technical factors:* In some areas, it may become necessary to dry grains prior milling. Reasons are different from one place to another. For example it is not uncommon to soak grain in water in order to get rid of contaminants. Examples from the Near East are sundried to harden. However, if the weather is bad, drying is carried out in ovens. In southern Spain, grain is not only soaked to get rid of contaminants, but also to soften it to avoid burning when milled, (Escalera Reyes, 1985). After soaking, the grain is spread on a flat surface to sun dry.

A second technical reason to dry grains, this time sprouted, is the need to eliminate humidity before milling. Malted-grain is used for bread in many areas of north western and central Europe due to its tasty flavour. Archaeological evidence from Roman Britain suggests that such an activity was carried out in kilns (Hillman, 1982).

A third technical factor is the need to remove a part of the ear. This is the case of emmer and spelt from Asturias (Buxò i Capdevila, 1989; Peña-Chocarro, 1994, 1996, 1999). The robust awns of these particular varieties make difficult dehusking, so farmers get rid of them using fire. This is a very peculiar example of the use of fire in the processing sequence of emmer and spelt. The actual Spanish term used for describing this activity, is very clear and refers to the elimination of the awns. The operation, is performed as follows: the crop (generally small quantities) is piled in a heap next to a small fire. With a fork, the farmer scoops up several ears and shakes it over the fire causing ears to fall to the ground (fig. 6). The fire may spread slowly and uninterruptedly as the burning ears get mixed up with the remaining crop, but by throwing the burning ears into the air, flames are extinguished. The job is done very quickly avoiding the fire to spread ears. The final result is the elimination of the robust awns and partial parching of some glumes.

In some villages, this operation is applied only to that portion of the crop which is going to be sown the following year. This perhaps supports the idea of parching being related to a different reason from that of making pounding easier. In other areas, this operation is applied to the crop prior to being dehusked in special mills.

Finally, Hillman (1981, 1982, 1984a, 1984b, 1985 and pers. comm.) provides an example of another technical factor: the parching of ears to make them more easily "breakable". He claimed that the parching of emmer to facilitate the breaking up of the ear into spikelets was only observed in two Turkish villages, located in an area of high rainfall. As this was never observed in other villages of the wetter Turkey, he suggested (Hillman pers.com.) that it is quite possible that the only reason farmers were using parching was that the spikelets were still damp.

Summarizing, many situations have been described, but so far, the examination of the ethnographic evidence, seems to show a different picture of that traditionally assumed, that parching is necessary before dehusking in order to render the chaff brittle and make

pounding easier. Both ethnography and experimentation suggest that, at some point in the crop processing sequence, the crop can enter in contact with fire, but they also illustrate that such contact has little to do with rendering chaff brittle. Different factors may influence the heating of the crop, particularly in areas of wet summer where the crop, at harvest time, can be rather damp. Apart from environmental constraints, hulled wheats may also be heated according to population taste preferences, as many other cereals, emmer was surely tastier if roasted. Finally, there are also technical reasons that may lead to heat hulled wheats, e.g. the need to dry out malted grains, or the necessity of eliminate the awns before dehushing.

## Dehushing

Dehushing is, perhaps, one of the most important operations of the hulled-wheat processing sequence, since it allows the grain to be freed from the chaff. The techniques most commonly used are: pounding and dehushing with water and hand mills. Classical authors such as Varro and Pliny provide evidence of such practices already for Roman times.

For recent times, ethnographic studies are a good source of information. However, in most regions where hulled wheats are still cultivated, dehushing is not practised anymore. In some cases, because the crop is fed to the animals in the form of spikelets; in some others, because dehushing has been mechanized. Nevertheless, there are still areas, such as northern Morocco, where hulled wheats (in this case einkorn) are used for human consumption, and dehushing is still performed as it was in the past. This example provides an excellent opportunity to study the range of techniques used.

The variability in dehushing techniques depends, on whether the bulk of the crop is processed in one single operation, generally outdoors, or, on the contrary, on small scale basis. The choice, at least for Turkey, in the recent past, seemed to depend on climate conditions (Hillman, 1984b). So, in regions with wet summers, processing used to take place at small scale on daily basis, whereas in areas of dry summers, emmer was processed at large scale, using large sized mortars worked by several men.

In the Rif (Morocco), olive mills were exceptionally used in the past for large quantities of einkorn. However, nowadays, over the area under research, all the dehushing takes place on small scale.

Traditionally, in the Rif, dehushing is performed inside holes of a curved parabolic section, excavated in the earth like sunken mortars (*zouaba*) (fig. 7). Diametres range between 20-30 cm and depth between 20-40 cm. The hole can be plastered or not, and it can be excavated both indoors or outdoors. For the mallet a light wood such as fig wood is preferred.

An alternative technique is the use of domestic rotary querns, commonly used in the area for cereal grinding, with a sheet of cork introduced in between both stones. The softness of the cork allows the grain to be dehushed without being crushed. A variation of this consists on fixing sheets of cork directly to the ground. In these cases, the upper stone is placed on top of the cork sheet, which works as lower stone. In both modalities a drive shaft is fitted, and spikelets introduced through the middle hole. The use of rotary querns are also described for Turkey by Hillman (1984b), and for Slovakia by Gunda (1983).

For small amounts spikelets are rubbed against the surface of a large flat basket using a circular piece of cork (fig. 8). Sometimes, rubbing is performed right with the palm as it is also documented from Transylvania (Gunda, 1983) where einkorn ears are rubbed out by hand. Finally, farmers may also use the small mallet (*rsama* or *marzab*) described above, as a rubber.

In Asturias, where emmer and spelt are still used for human consumption, all the dehushing is carried out in water mills. This is also common in other areas such as Turkey (Hillman, 1984b; Nesbitt & Samuel, 1996). It should be noted, though, that, in Asturias, at least until the beginning of the XXth century, pounding in stone mortars called "pilones" was still practised in some areas. According to old farmers, the aim was, however, to dehush the most rebellious spikelets that the mill had not shell. The device consisted in a swinging wooden board or beam with a mallet at one end and a mortar. The board was operated by a man with his feet. By tilting the swinging board the mallet fell, pounding the spikelets within

the mortar. A reference to this kind of device appeared in a work on Asturian hulled wheats (Alvargonzález, 1908), where the author noticed the similarities between the Asturian tool and the devices used for pounding flax. It may be inferred that, prior to the invention of shelling mills in Asturias, pounding was the usual way of dehushing hulled wheats, just as it was in SW Asia (Hillman, 1984b, who also records the replacement of pestle and mortars by special mills, e.g. in the emmer growing areas of Kars Province). It seems also clear that both methods were in use until the beginning of the XXth century.

Mortars and pestles of this type were commonly used in Europe for processing both millet and flax. According to Dias (1950), this type of dehushing device, that worked either by human or water power, can be traced in areas of eastern Asia (China, Japan, Korea, Indonesia, Indochina, and India) as well as in Europe (Ukraine, Transcaucasia, Poland, Switzerland, Hungary, Italy, France, Spain and Portugal). Gunda (1983) and Markus (1989) describe mortars of this type for the Carpathian area, and Bennett & Elton (1898) mention their use in China and Central Asia.

Once spikelets are dehushed, women perform a series of several rounds of winnowing, sieving and hand sorting until the grains are fully clean and ready for human consumption.

## Conclusions

Traditionally, much of the ethnoarchaeological research has been carried out amongst groups of hunter-gatherers, forgetting that farmers possess also an enormous knowledge about both cultivated and wild plants. Traditional farmers have played, in the past and present, a very important role in the conservation of agricultural diversity, and the safeguarding of a wide range of techniques and practices. Today, this knowledge has become a crucial element for the conservation of plant genetic resources and people's cultural heritage. For the archaeobotanical research, these communities offer the possibility to directly observe many agricultural operations and study their effects in the plant remains. Consequently, it is possible to reach to a better understanding of the archaeological remains and interpret them in terms of past human behaviour. However, modern trends towards global standardization are threatening these rural farming communities with a considerable risk of losing a great deal of information. The communities under research are clear examples of this vast disappearing knowledge.

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## CAPTIONS

Fig.1. Map showing the distribution of hulled wheats in the areas under research

Fig.2. Threshing einkorn by trampling with animals in southern Spain

Fig. 3. Threshing by flailing in Asturias (Spain)

Fig.4. Breaking einkorn ears into spikelets using a wooden hammer (northern Morocco)

Fig.5. Lashing einkorn sheaves to break ears into spikelets (northern Morocco)

Fig.6 Singeing of awns of hulled wheats in Asturias (Spain)

Fig. 7. Dehusking einkorn in sunken mortars ("zouaba") in northern Morocco

Fig.8. Dehusking einkorn by rubbing spikelets with a piece of cork (northern Morocco)