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LIQUID BREAD

Beer and Brewing in Cross-Cultural Perspective

Edited by

Wulf Schiefenhövel and Helen Macbeth

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CHAPTER 4

INTERDISCIPLINARY INVESTIGATIONS INTO THE BREWING TECHNOLOGY OF THE ANCIENT NEAR EAST AND THE POTENTIAL OF THE COLD MASHING PROCESS

Martin Zarnkow, Adelheid Otto and *Berthold Einwag*

The ancient Near East was the homeland of beer brewing. Numerous written documents from the third millennium BC onwards inform us about the fundamental role of beer for daily alimentation and social events (Milano 1994). Considering the amount of consumed beer, brewing must have taken place on a large scale. However, no clear archaeological evidence for brewing has so far been found in a private or an official building at a Mesopotamian site.

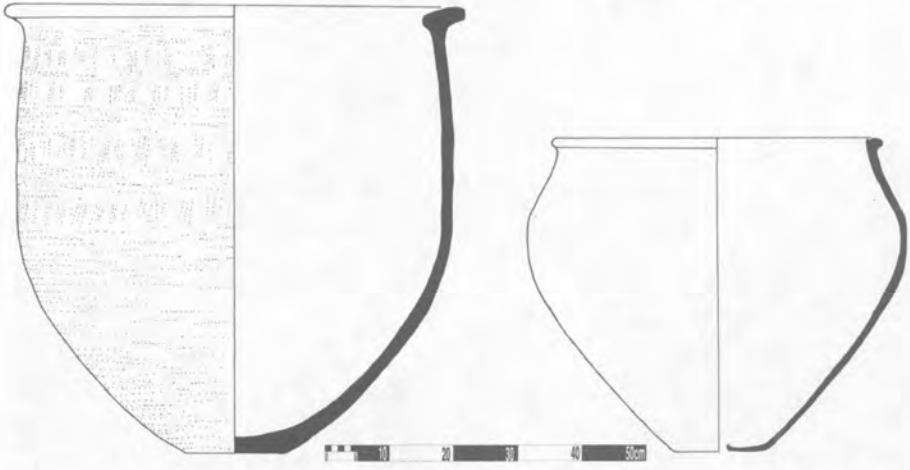

Figure 4.1 Large 'beer vat' (approximately 200 litre volume) and a vessel with a hole in the bottom (90–110 litre volume).

New Hints for Ancient Brewing at the North Mesopotamian Site of Tall Bazi

Excavations at Tall Bazi in Northern Syria have led to new insights into malt and beer making in ancient times (Zarnkow, Spieleder *et al.* 2006). At Tall Bazi, located in the Euphrates valley, fifty houses of the Late Bronze Age settlement (fourteenth to thirteenth century BC) served for residential purposes and for production of objects of all kinds. Unknown circumstances led to the sudden destruction of the city and the conservation of many objects of the daily life within these houses. The very similar organisation of the houses and their contents allowed detailed insights into the daily activities of the inhabitants (Einwag and Otto 2002).

One of the most remarkable features was the repeated combination of three ceramic vessels at a certain location in the houses: A large vat with a volume of up to 200 litres with a wide opening and a thickened rim was found in nearly every house (Figure 4.1). This largest vessel of the ceramic inventory was always set into the ground and immobile (Figure 4.2). Often associated was a slightly smaller vessel (ca. 90–110 litres) with a hole in the bottom (Figure 4.1). Large storage jars, which served for storing solid food and often still contained carbonised barley, completed the set. The question was; which liquid the vat and the large vessel may have contained? Drinking water can be excluded,

Figure 4.2 A large beer vat and a grinding installation in two neighbouring rooms of house 17 at Tall Bazi.

because the vat could not be cleaned thoroughly, and the microbial growth in water must have been considerable in the warm climate. Other liquids which were consumed at that time such as oil, wine or honey are unlikely, because storage jars have in general narrow openings for easy closing. The position of the large vat near the entrance and under the staircase showed that good ventilation was sought. These considerations in combination with our knowledge about the high amount of beer consumption in the ancient Near East made beer a good candidate for these vessels.

This state of the question made scientific residue analysis necessary. In order to identify the liquid, sherds of the above-mentioned pots and of other vessels which presumably might have been connected with beer and wine were subjected to spot tests (Feigl 1960). In some instances, residues of tartrate were found, which indicates that they contained wine. Several of the above-mentioned vats and vessels with a hole in the bottom were found to contain residues of oxalate. Oxalate crystals are formed when grain is mixed with an excess of water. After a 24-hour steep of 200g of barley in 0.5 l of water, 7.6 mg/l of oxalate was formed (Zarnkow, Spieleder *et al.* 2006). As oxalate can arise from other plants, for example rhubarb (290–640 mg of oxalic acid/l: Souci, Fachmann *et al.* 2000), an oxalate find does not necessarily provide evidence for beer. However, the probability is high. As no tartrate was found in these vessels, wine or grape juice can be eliminated as a starting medium for fermentation (yeast cells on the surface of the grapes). Some yeast cells were also found in isolated cases. Yeasts are, however, ubiquitous in the vicinity and thus only an indication for fermentation though not a compelling proof. A further indication is provided by sporadic starch grains found on the fragments. Important utensils such as stirring spoons or reed mats as working tools were not found because they were made of organic materials which are seldom preserved in archaeological sites. These utensils can, however, be assumed to have been used by the inhabitants of Tall Bazi.

The first conclusion that can be drawn is that the large vessels possibly had a role in the brewing process. This is indicated by the fact that the beer vessel is fixed in the floor. This presupposes that what it contained was not hygienically vulnerable because the vessel could not be completely cleaned. On the other hand, contact with the floor ensured that there was a cooling effect, something that must have been of particular interest in summer. As the vessel was only half sunk into the earth and the remainder was exposed to the influence of the ambient temperature, a temperature difference arose during fermentation (only 2.7 per cent of the total energy is chemically bound in the anaerobic phase, the remainder is heat energy (Narziss 2005), leading to a circulation within the vessel.

However, in order to achieve a greater degree of certitude about the possibility of ancient brewing at Tall Bazi, it was necessary to brew a 'Bazi beer' on location and with equipment similar to the ancient one, taking into account the conditions of the antiquity.

The Climatic and Botanic Situation

Tall Bazi lies at the edge of the rain-farming zone. It can be assumed that the climate in the Late Bronze Age was similar to that of the present day (Wirth 1971). The Euphrates region was then covered with sparse alluvial forest, and the few trees were used more in construction than as firewood. Twigs and animal dung were used in the latter case. A palaeobotanic analysis of grain showed up mainly multi-rowed barley, and rarely naked wheat and emmer. Some barley grains showed clear signs of germination.

The Technological Situation

It has to be assumed that the male and female beer brewers of Tall Bazi had a more than adequate technological range of experience. These people were very well trained in handicrafts and were in a position to make a product in a reproducible manner which was seen to be valuable enough to find mention in numerous written documents (Röllig 1970). There are other aspects associated with beer production that will be dealt with below. One asset is that it is possible to have a drinkable beverage in storage and keep it suitable for drinking as a result of the low pH value, because the occurrence of pathogenic germs is prevented (Back 1994). Furthermore, beer is a nutritious beverage with many physiological benefits. As the cuneiform texts do not inform us which grain was used in which state for malt and beer making, it has to be made clear right from the beginning that, from a technological standpoint, malt was and is a fixed feature of beer preparation. Otherwise, the nutritive and alcoholic yield is much too low because the required amylolytic enzymes that are capable of converting native cereal starch to a sugar which can be fermented by yeast are not present. Extensive preliminary trials showed that high alcohol yield is possible only with malt. Most fermentations based on unmalted grain had no appreciable alcohol yields. Boiled, therefore gelatinisised, unmalted barley grist was the only one having a small yield, comparable to half the alcoholic content when using malt grist (Zarnkow, Spieleder *et al.* 2006). Consequently, amylolytic enzymes are present in sufficient measure only when the grain has germinated and thus malted. Another important aspect is the adequate presence of amino acids in the malt wort for supporting yeast growth, allowing multiple yeast cycles without any problem. Repitching use of yeast is the most conceivably sensible variant. It is hard to imagine that a male or female beer brewer would not have recognised the benefit of a 'live' fermenting foam cover of a top-fermenting fermentation. This in no way indicates that only malt was used. It was certainly also the case that unmalted starch sources were used (Jennings, Antrobus *et al.* 2005). Forms of pre-gelatinised starch such as bulgur (boiled, unmilled grains) or bread are conceivable.

Brewing Experiments According to the Technology of Antiquity

On the basis of the archaeological, climatic and botanical conditions described, brewing tests were directed towards producing a drinkable beer without artificial heat input. This very unusual technology has to be regarded as a basic technology of the Bazi brewers of 3,200 years ago. This basic technology can be extended in every direction (heating, flavouring, etc.). Cold mashing involves having an enzyme potential present and that the starch has to go through pre-gelatinisation. Malt can provide both of these conditions to a sufficient extent. Malt bread cannot be considered as pre-gelatinised starch due to the site conditions (no baking moulds) and the extremely liquid dough that arose in the tests.

Malting

We found that the hole-bottomed vessels were extremely suitable as steeping and germination vessels. Germination could be carried out, on the one hand, in vessels and, on the other hand on mats (we used mats). The local rooms, built from sun-dried mud bricks in the same way as the ancient rooms millennia

Figure 4.3 Spreading out green malt on the roof for kilning.

earlier, assured a constant pile temperature of about 24°C during germination. The green malt was turned over twice a day by us, and germination was completed after four days. Kilning took place on the flat roof of the houses, consisting of mud (Figure 4.3). Here, an important factor emerged. 60°C was reached in the summer months without any problem whereas only 45°C was measured in April (but in both cases water contents of the malted barley were under 14%, therefore storage conditions were reached). This could be an indication of seasonal malting, supported by the fact that the barley varieties still used today require a long dormancy (germination power 09/2004: 50 per cent and 04/2005: 82 per cent; both from the 04/2004 crop). After approximately one year dormancy, it was possible to malt the barley into better malt.

Milling the Malt

The dry malt was milled on a saddle quern with a grinding stone (Figure 4.4), both consisting of basalt or coarse-grained limestone. Mortars were also found in Bazi but we preferred the saddle mill in a practical comparison of both milling systems. In some instances the milling installation was carefully set on a floor plastered with sherds (Figure 4.2); more frequently, however, milling took place at a better ventilated area, namely on the roof of the house.

Figure 4.4 Grinding the Bazi malt on a saddle quern.

Mashing, Wort Preparation and the Fermentation Process

Mashing-in was carried out at 34°C, with vigorous stirring for 15 min, using a grist/water mixing ratio of 1:8.3. A mixture of *Saccaromyces* and *Schizosaccharomyces* yeasts as well as *Lactobacillus* species were added to the mash subsequently, and the mix was allowed to rest for 36 hours at about 24°C. A mixture of alcoholic and lactic acid fermentation is the most conceivable probability, as shown by pre-tests. With a view to a low alcoholic content, the resulting beers were mashed in very dilute form because the ancient beers must have been drunk by all sections of the population including children (Stol 1994). The obtained experimental beers had the anticipated low alcoholic content (1.6 vol per cent). They were highly fermented (final attenuation 87.0 per cent), standard in terms of saccharification (0.118 in the photometric iodine sample) and, with a pH of 3.90, provided a certain degree of safety against microbial contamination. The beers were stable for over two months under modern storage conditions (6°C). The much diversified taster panel assembled on location certified the beers as having a pleasant lively character with enjoyable consumption potential.

Summary

Based on a multiplicity of archaeological and palaeobotanical circumstantial evidence, we succeeded in discovering a conceivable process for ancient oriental malt and beer production for the period around the fourteenth/thirteenth century BC, using experimental test series on location. This is a cold mashing process in large beer vessels with malt or malt surrogates which had been previously steeped and germinated in base-tapped vessels. Germination could also be continued and completed on a mat. The mashing process was followed by a heterogeneous fermentation which most probably resulted from intentional propagation. Many questions are still open in relation to Bronze Age malt and beer production. With this interdisciplinary approach (archaeology, brewing technology), a new effort is made to investigate the many remaining questions about ancient beer brewing.

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