BRAUWELT INTERNATIONAL | REPORT

270 AUSTRALIA: Unwanted attention
270 AUSTRALIA: SABMiller announces joint-venture with CCA
270 BELGIUM: InBev adjusts global management structure
271 CANADA: Sleeman sold to Sapporo
272 CANADA: Wine in PET
272 COLOMBIA: Courage and faith
273 EU: Beer prices to go up in nine European countries
273 GERMANY: Where there is smoke...
274 INDIA: PR disaster
274 IRELAND: Innovations galore
275 NETHERLANDS: Heineken on the beach
276 SOUTH AFRICA: The spiral of violence
276 SPAIN: Building a new brewery
277 UK: It's hot under the counter
277 UK: Make mine a Heineken
277 USA: Combating a stagnant market

BRAUWELT INTERNATIONAL | MARKET

280 To be or not to be...

BRAUWELT INTERNATIONAL | KNOWLEDGE

REFRIGERATING
286 Detection of ammonia in brine

YEAST
288 Methods of recovering barn beer from excess yeast

ANALYTICS
294 Configuration of a Manufacturing Execution System for bottling
330 Oxygen ingress measurement into PET bottles using optical-chemical sensor technology
338 pH measurement in carbonized beer

FILLING
299 Modular sorting and order picking concepts
311 Process technology for soft drinks

HISTORY
306 Cold mashing process – a technology possibly used in ancient times in the Orient

BREWHOUSE
314 Subjet wort boiling – physical phenomena and technology during heating and boiling phase

PROCESS AUTOMATISATION
324 Changeover of brewhouse control system from Brauma to brewmaxx

MALTINGS
334 Fully-automated EUR 4-million logistics centre

MEASUREMENT TECHNOLOGY
341 Intelligent pH and oxygen sensors

BRAUWELT INTERNATIONAL | INSTITUTES

320 Institute Romeis

BRAUWELT INTERNATIONAL | SECTIONS

267 EDITORIAL
278 NEWS OF THE SECTOR: Business of brewmaxx GmbH & Co KG new defined
278 CONFERENCES & EVENTS: 31st EBC Congress: Call for Posters
278 CONFERENCES & EVENTS: Pianeta Birra Beverage & Co.
326 TECH NEWS: Highly efficient PET recycling
340 IMPRINT
342 ADVERTISERS' INDEX

In this issue you will find an insert from Assured UK Malt.
Cold mashing process – a technology possibly used in ancient times in the Orient

ANCIENT ORIENTAL BREWING CRAFT | Not only was the first beer brewed in ancient times in the Orient, it was also one of the main foodstuffs in the region. Excavations in Tall Bazi in Northern Syria have led to new insights into malt and beer making in ancient times. The following contribution contains a summary of these findings, based on an article “Interdisciplinary Investigations into Ancient Oriental Beer Brewing in the Tall Bazi/Northern Syrian settlement about 3200 years ago”. (1)

ANCIENT ORIENTAL BREWING CRAFT is well-known from written sources but has been practically not confirmed up to now by archaeological evidence. This makes new findings regarding malt and beer making from the Tall Bazi site in Northern Syria all the more interesting. The site is located 60 km south of the border with Turkey, on the Eastern shore of the Tishrin reservoir dammed since 1999. Excavations were concentrated until 1999 on the western lower city that has been excavated over a wide area and is meantime largely submerged. It is an extension of a settlement with an urban character established in the 13th century B.C. About 50 houses served for residential purposes and for production of objects of all kinds (2).

Details of find
Unknown circumstances led to the city being abruptly abandoned. This gave rise to a find horizon where most objects of daily living are preserved. Organic artefacts are largely decomposed due to weathering, a remarkable feature is that ceramic vessels are present in houses in a standardised form and location. Vessels of volumes up to 2001 with a wide opening are especially striking (Fig. 1). In all instances, they were sunk in the floor at the best ventilated location in the house. In addition, vessels with a tapping in the base were found in practically all houses (Fig. 1), with about half the volume of the large vessels (90-110 l).

In contrast to other storage vessels, no bulk goods of any description were found in both types of vessels. This raises the question as to whether they might have contained liquids. Drinking water can be eliminated due to the unavoidable microbial growth in water when left standing in this climate. Other liquids such as oil, honey or wine are also out of the question because the vessels are too large for storage of such valuable liquids for a single household.

In order to identify the liquid, broken fragments of the vessels referred to as well as others that, based on archaeological indications, might have been connected with beer or wine were subjected to spot tests (3). In some instances, residues of tartarate were found, in good agreement with archaeological indications. Especially the above-mentioned vessels were found to contain residues of oxalate, while vessels with the base tapping have been used for at least two purposes. It emerged in the course of investigations that the large vessel could be referred to as a “beer vessel”. Oxalate crystals are formed when grain is mixed with an excess of water. 7.6 mg/l of oxalate was formed after a 24 hour steep of 200 g of barley in 0.5 l water (1). As oxalate can arise from other plants, for example rhubarb (290-640 mg of oxalic acid/l (4)), an oxalate find does not necessarily provide evidence for beer. However, the probability is high. As no tartarate was found in the beer vessels, wine or better still 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 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 (organic!). These utensils can, however, be assumed to have been used in the culture.

Other objects found in Tall Bazi allow conclusions to be drawn about inadequate separation between solid and liquid components in the liquid: numerous bronze filter points were found which were pressed onto the ends of suction pipes in order to drink liquid from a communal vessel, such as is usual up until the present day in various African societies (Fig. 2).

Authors: Martin Zarnkow, Elnar Spiegeler; Prof. Dr. Werner Back, Technical University Munich, Faculty of Technology of Brewing w.Freising; Dr. Bertram Sacher, Doemens eV., Grafelfing; A. Otto, B. Binuw, LMU Munich, Institute for Archaeology of Asia Minor, Munich

Fig. 1 Large 200 l volume “beer vessel” and a so-called base-tapped vessel having 90-110 l volume
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 was fixed in the floor. This presupposes that what it contained was not hygienically vulnerable because the vessel could not be cleaned. On the other hand, contact with the floor ensured that there was a cooling effect, something that was of particular interest in summer. As the vessel was only half sunk in the earth and the remainder was exposed to the influence of the ambient temperature, a temperature difference arose during fermentation (only 2.7% of the total energy is chemically bound in the anaerobic phase, the remainder is heat energy (6)), leading to a circulation within the vessel. However, in order to achieve a greater degree of certitude, it was necessary to brew a "Bazi beer" on location, taking account of conditions in antiquity.

Climatic and botanic situation

Tall Bazi is on the edge of a rain-fed farming zone. It can be assumed that the climate in 1200 B.C. was similar to that of the present day (7). 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 paleobotanic analysis of grain showed up mainly multi-rowed barley, and rarely naked wheat and emmer. Some barley grains showed clear signs of germination.

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 very many written documents (8).

There are other aspects associated with beer production that will be dealt with below. One asset is that it is possible to have water in storage and keep it suitable for drinking as a result of the low pH value, as the occurrence of pathogenic germs is prevented (9). Furthermore, beer is a nutritious beverage with many physiological benefits.

As no progress has been made heretofore in deciphering cuneiform writing, such as which grain was used in which stage 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 utilised by yeast are not present. Extensive pre-tests showed that high alcohol yield is possible only with malt. Most fermentations based on unmalted grain had an appreciable alcohol yields. Boiled unmalted barley grist was the only one having a small yield, comparable to half the alcoholic content when using malt grist (1).

Consequently, amylolytic enzymes are present in sufficient measure only when the grain has germinated and thus malted. An important aspect which also speaks in favour of the use of malt is the adequate presence of amino acids in the malt wort for supporting yeast growth, allowing multiple yeast cycles without any problem. Conscius 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 utility value of a "live" fermenting foam cover of a top-fermenting fermentation.


<table>
<thead>
<tr>
<th></th>
<th>Extract</th>
<th>Saccharification</th>
<th>Final attenuation</th>
<th>FAN</th>
<th>α-amylase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% anhydrous</td>
<td>&lt;15</td>
<td>%</td>
<td>mg/100 g malt dry matter</td>
<td>ASBC anhydrous</td>
</tr>
<tr>
<td>Bazi malt (standard)</td>
<td>72,2</td>
<td>74,2</td>
<td>79</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Bazi malt (9/04)</td>
<td>71,2</td>
<td>keine</td>
<td>62,8</td>
<td>59</td>
<td>6</td>
</tr>
<tr>
<td>Bazi malt (4/05)</td>
<td>69,5</td>
<td>15 – 20</td>
<td>70,8</td>
<td>88</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1

This in no way indicates that only malt was used. It was certainly also the case that unmalted starch sources were used (10). Forms of pre-gelatinised starch such as bulgur (boiled, unmilled grains) or bread are conceivable.

Experimentally determined findings relating to 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 extreme technology has to be regarded as basic technology of the "western" brewers of 3,200 years ago. This basic technology can be extended in every direction (heating, flavoring 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

It was found that the base-topped vessels were extremely suitable as steeping and germination vessels. Germination was carried out, on the one hand, in vessels and, on the other hand, on mats. The working area, constructed as originally from terracotta tiles, assured a constant pile temperature of about 24°C during germination. The pile
The beers had the anticipated low alcoholic content (1.6 vol %). They were highly fermented (final attenuation 87.0%), standard in terms of iodine (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 in Germany for over two months. The very 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 paleobotanical circumstantial evidence, we succeeded in coming up with a conceivable process for ancient oriental malt and beer production for the period around 1200 B.C. using experimental test series on location. This is a cold mashing process in large beer vessels with malt or malt elements 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), new impetus should be given to solving this historical puzzle.

**References**