Katharina Neumann*, Barbara Eichhorn†, Hans-Peter Wotzka
Iron Age plant subsistence in the Inner Congo Basin (DR Congo)
Vegetation History and Archaeobotany

*Goethe University Frankfurt, Germany
Email: k.neumann@em.uni-frankfurt.de

Online Resource 5

Pearl millet germination, cooking and charring (Summary of Eichhorn 2019)

Some of the detected Iron Age archaeobotanical charred pearl millet caryopses display significant morphological modifications in their embryonic areas. These alterations are reminiscent of the modifications previously observed in European archaeobotanical germinated cereal grains and interpreted as evidence for the process of malting in the context of beer brewing (e.g. Stika 1996, 2011; Bouby et al. 2011; Larsson et al. 2018; Valamoti 2018). In order to test whether the observed modifications may indeed be related to sprouting we created a series of reference experiments in which pearl millet caryopses from southern Ghana were germinated under controlled conditions. In the course of this process, the induced morphological changes were repeatedly documented photographically and described. Afterwards, a part of the germinated and non-germinated caryopses were cooked and charred in cookware simulating incidental charring during preparation. Another part was charred under reducing conditions, i.e. wrapped in aluminium foil on an electric cooking plate, simulating accidental charring during storage.

After ten hours of incubation in wet kitchen paper, first distinct changes in caryopsis morphology became evident. The caryopses were distinctly swollen in the area of the embryonic axis and the scutellum was thus raised. In some individuals, the coleorhiza and/or the radicle had already broken through, but the radicle was still short, whereas the coleoptile had not yet emerged. Fourteen hours after starting the germination experiment, the coleorhiza and/or the radicle were visible in most of the caryopses (Eichhorn 2019:Fig. 3a). In a few cases, the coleoptile was emerging but either not yet broken through the testa or still very short. A few caryopses still showed no clear signs of germination. After 34 hours, the radicle was well developed and the coleoptile either broken through the testa or already grown to a few millimetres length. Some caryopses lagged behind in development whereas others did not germinate at all. At that point, the incubation experiment was stopped because none of the archaeobotanical charred caryopses showed coleorhizas/radicles or coleoptiles longer than the modern ones at that germination stage.

The cooked and charred non-germinated, entire pearl millet caryopses show modifications different from those discernible in the germinated individuals. The testa and pericarp are torn and the endosperm exposed, whereas no distinct modifications are visible in the embryonic areas. When individual caryopses came into direct contact during the cooking and charring process, conglomerates developed which are agglutinated by the denatured starchy endosperm, oozing out of the caryopses through breaks in testa and pericarp.

The intentional charring of the germinated caryopses resulted in various modifications: While in many cases the emerged radicula and coleoptile are preserved (Eichhorn 2019:Fig. 3b–c), they are

completely converted to ash or broken off (Eichhorn 2019:Fig. 3d-e) in others. In the latter cases, the embryonic area is characterised by a large cavity with, if at all, only the stumps of radicula and coleoptile remaining.

In European potential brewing contexts, the caryopses show various rather similar modifications: either groove-like channels on their dorsal sides; the dorsal side develops a concave shape; the coleoptiles and coleorhizae become more prominent; coleoptile, coleorhizae and primary roots develop; and/or the germination pit enlarges in an inverted V-shape towards the top. Lastly, the caryopses may break transversally in their middle (Stika 1996:83).

Pearl millet cultivation experiment (Summary of Wotzka 2019)

In 2016, experimental cultivation of two different pearl millet accessions was conducted at an ICB rainforest site close to the equator in order to test the general assumption that successful pearl millet cultivation is only possible under distinctly seasonal climatic conditions with a marked dry season. The two varieties, one presently cultivated in Ghana (GHANA), the other one purchased from an internet seed market (JESTER) were sown in an enclosed treeless garden compound at Iyonda Catholic Mission. According to the climate diagram for the nearby provincial capital Mbandaka average annual precipitation amounts to 1675 mm without a distinct dry season (Climate-data-org 2020). The pearl millet was cultivated during the most humid months of the year. It performed with little labour input, including (1) protection of the young seedlings with mosquito nets, (2) regular control, (3) occasional weeding, (4) fencing and support of the growing plants with bamboo sticks, (5) protection of the maturing infrutescences with nets against insect and bird damage. Flowering of the pearl millet plants occurred about 9 weeks (JESTER) and approximately 10 weeks (GHANA) after sowing and full grain ripening followed mostly after 13 weeks. The majority of the infrutescences could be harvested after a period of 95 days. Their number varied between 2 and 8 per plant (JESTER) and 2–11 per plant (GHANA). Detailed results for each plant are displayed in Wotzka (2019:Fig. 6). Despite high air humidity, strong rainfall events and constant day/night length at the equator the caryopses reached physiological maturity, expressed by a dark spot in the hilum area (Maiti and Bidinger 1981).

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