

# TESTING EFFICACY OF FLOTATION SYSTEMS USING STRATEGICALLY INTRODUCED SEEDS

## A Case Study from Triblavina, an Early Iron Age Settlement in Slovakia

Caleb Ranum



DOI: <https://doi.org/10.31577/szausav.2025.72.18>

*Keywords: Archaeobotany, Flotation, Wash-over, Recovery Rate, Calibration Testing*

Plant remains recovered by archaeobotanists undergo multiple levels of processing before arriving in the laboratory. The impact of these archaeological practices on the recovery of archaeobotanical data needs to be considered. In Central Europe flotation machines are an essential component of the process for recovering ancient plant remains, but what impact do they have on the recovery of this material? This study advocates for the adoption of a variant of the “poppy seed test” commonly used in American archaeology for testing the efficacy of flotation systems. This test functions by adding a known number of archaeologically absent carbonized seeds to samples before flotation and recording their rate of recovery in the final product. This paper demonstrates the method in a case study looking at Early Iron Age plant remains from Triblavina. It enables archaeobotanists to understand the impact of flotation methods on seed recovery.

### INTRODUCTION

Flotation is an essential part of the archaeobotanist’s toolkit but like any tool it must be inspected to ensure proper functionality. The study of archaeobotanical methods and their impact on the recovery of plant remains at archaeological sites has a long history. Following Stuart Struvever’s 1968 article introducing flotation, a variety of water-based systems began to see widespread use in the early 1970’s. The proliferation of this technique and subsequent iterations in the flotation process led to a crisis in comparability of results between archaeologists using different flotation systems (Struvever 1968; Wagner 1982). Significant differences in flotation practices exist to this day as archaeobotanists adapt to a variety of field conditions and economic restrictions (Miller 2011). In addition, biases arise during the flotation process as archaeobotanists face decisions in how to proceed. A key example of potential biases is whether samples are dried or pre-soaked before they are floted. Depending on the quality of the soil, drying or soaking ahead of time can shorten the time needed to flot each sample but these practices (and general ecological conditions) have the potential to damage carbonized remains (Wagner 1988). In addition, depending on environmental conditions flotation can result in a different spectrum of recovered material than other methods like dry-screening (Chiou/Cook/Hastorf 2013).

To address concerns about comparability, the biases created by flotation, and to ensure as accurate as possible recovery of plant remains, archaeologists have developed methods for testing the recovery rate of flotation systems. The earliest effort to test recovery rate involved placing carbonized plant remains in sterile sand and recording the recovery rate of remains with different sizes and shapes (Jarman/Legge/Charles 1972). Soon after archaeobotanists in the United States developed a method for testing flotation recovery rates while processing archaeological samples. This method involves inserting a known number of charred foreign seeds into a sample before it is processed. In the eastern United States, poppy seeds (*Papaver somniferum* L.) were used because they are not native to the Americas and as a result totally absent from prehistoric contexts, their unique shape makes them unlikely to be confused with other species, and their size is comparable with other seeds likely to be found in the region

(Kaplan/Maina 1977; Wagner 1982). Archaeobotanists record the recovery rate of the poppy seeds, where they are found (heavy vs light fraction), and note any damage done. Known as the “poppy seed recovery standard”, this method allows archaeobotanists to understand how well their flotation system is processing material and if it is causing any damage to the carbonized remains (Wagner 1982). Notably this test is not perfectly representative of the recovery of archaeological remains, as they are more fully mixed in the substrate and underwent carbonization under different conditions. It does provide a warning system for potential issues and provides a method of comparability between systems (Wagner 1982). This method continues to be used by American archaeologists to test not just the efficiency of flotation machines but also the impacts of different soils and environmental conditions by utilizing variations of the technique (Wright 2005). While testing efficiency of recovery is not unknown in Europe, especially in unusual conditions, these methods are less consistently applied (Tolar *et al.* 2010; Vandrope/Jacommet 2007).

This paper advocates for the testing of flotation processes by archaeobotanists and archaeologists in Central Europe using a modified version of the “poppy seed recovery standard”. This examination allows for confidence that the flotation process did not destroy or damage any carpological material. This modified method was applied in a successful trial run at the site of Triblavina, an Early Iron Age settlement located in western Slovakia.

## METHODS

In 2015, the construction of a new road connecting to the D1 highway required rescue excavations of a multiphase settlement at the site of Triblavina in the Bernolákovo cadaster east of Bratislava. Members of the Slovak Academy of Sciences: Institute of Archaeology led the project and discovered material remains from the Bronze Age, Iron Age, Roman Period, and the Medieval Period (Daňová 2017). During the excavation archaeobotanical samples were taken from select contexts, including a total of 36 samples from five Early Iron Age features.

These samples were transported to the Slovak Academy of Sciences: Institute of Archeology location in Nitra for processing and storage. Flotation was performed in the summer of 2022 using an SMAP style machine flotation system (Fig. 1). This system uses water pressure to break up soil by pumping water through a shower head or similar structure and into a drum lined with mesh. The sample is then placed on the mesh and as the water pressure breaks up the soil material lighter than water, known as the light fraction, flows out a spout and into a series of screens. The remaining material in the mesh, known as the heavy fraction, is then removed when the sample is sufficiently agitated (Watson 1976). The heavy fraction was then further processed using a manual wash-over technique and visual observation (Fig. 2). In this process the remaining heavy fraction is removed from the flotation tank and separated into individual buckets and processed via manual flotation. Water is added to the buckets, and they are swirled to break up remaining clumps of soil. The water is then slowly poured through a sieve, while the heavy fraction remains in the bucket. This process is repeated until the water from the buckets runs clear (Hajnalová 2022). The remaining heavy fraction is then laid on a large screen and analyzed by hand. If only single finds remain, they are removed by hand and the leftover product is discarded. In cases where significant ecofactual or artifactual evidence is present, the entire heavy fraction is dried and brought to the lab for further analysis (Hajnalová 2022).

The samples from Triblavina were generally clay soils that did not dissolve easily. To effect quicker processing times, the samples were manually stimulated while in the flotation tank. Additionally, the wash-over technique utilized in the flotation process assisted in breaking up the final soil clumps in the samples. Initial visual analysis of the samples from Triblavina revealed minimal and highly fragmented recovery of grains. As a precaution this modified version of the poppy seed test was applied ad hoc to determine if the poor preservation was due to the flotation process or other taphonomic conditions.

The first step was choosing an appropriate seed, that was both absent from the archaeological record, distinct morphologically, and approximately the same size as the expected archaeobotanical remains. After consultation with M. Hajnalová, sesame seeds (*Sesamum indicum* L.) were chosen because of their unique appearance, absence from the archaeological record during the Early Iron Age, and their intermediate size similar to weedy species and between expected finds like small millets and larger wheat and barley (Hajnalová 1989).



Fig. 1. The SNAP style flotation system utilized by the Slovak Institute of Archaeology for flotation of Triblavina Samples.



Fig. 2. Manual wash-over processing of heavy fraction using a bucket system.

The Ideal method of charring seeds for archaeological experimentation utilizes ceramic bowls in a muffle furnace (Märkle/Rösch 2008). When such a setup is unavailable, a combination of aluminum foil and a normal oven can be used. For the traditional poppy seeds, a temperature of  $\sim 260^{\circ}\text{C}$  is needed for 5 hours, but any method works as long as the seeds are burnt and not reduced to ash (Wagner 1982). For this experiment a similar approach was used, sesame seeds were put on aluminum foil and placed in the oven at  $\sim 260^{\circ}\text{C}$ . Due to a misstep during charring, the sesame seeds caught fire after  $\sim 45$  minutes. Although unintended, the resulting charred state was acceptable for experimentation. Due to time constraints only one batch of sesame seeds was carbonized, producing approximately 80 intact carbonized seeds. These seeds were sorted into three groups of 25 to be added to samples the next day. In ideal conditions at least 50 and preferably 100 seeds would be used per trial to ensure a large sample size and increased granularity in recovery rate (Wagner 1982).

The next day 25 seeds were mixed into three dry samples (#5205, #5206, and #5207) before they were processed by flotation. It is generally advisable that the individuals manning the flotation system are unaware of which samples

have been selected for testing to ensure that they do not receive special treatment (Wagner 1982). In this case the limited size of the flotation crew made this precaution impossible. To limit the impact

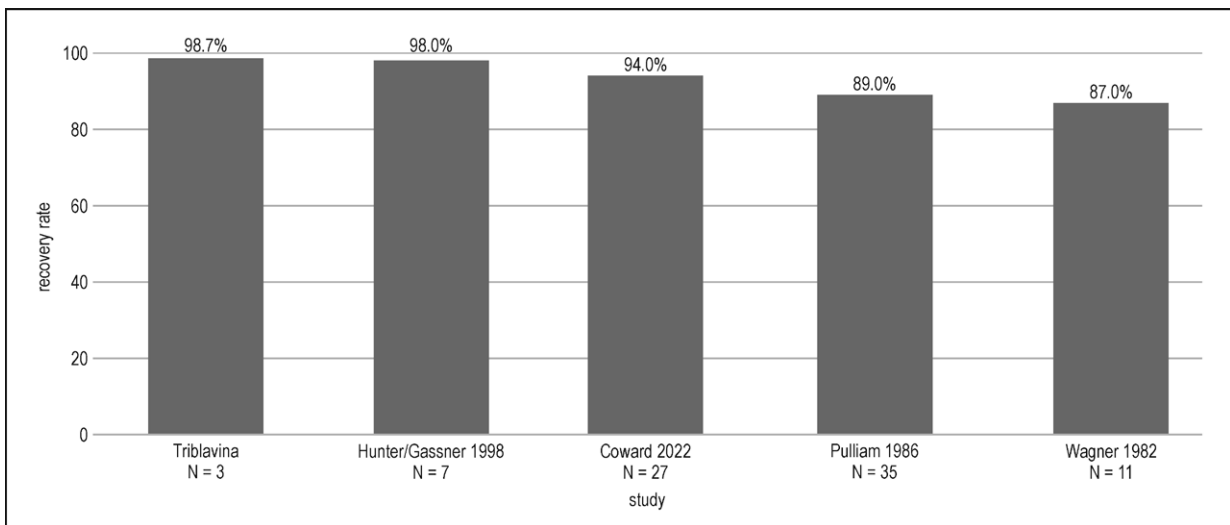


Fig. 3. Comparison of recovery rate from Triblavina with that of four other studies that performed the poppy seed recovery test or a modified version.

of potential bias, the seeds were mixed into the samples in advance and processed with the rest of the day's samples with no extra precautions. The samples with the added seeds were labeled as test sample on the flotation log. The samples were then floted using the SMAP style machine, the heavy fraction was processed by washing-over, after which all recovered material was combined and hung to dry.

After flotation, the material from Triblavina was transported to M. Hajnalova's archaeobotany laboratory for processing and storage. In the spring of 2024, the samples were sorted and analyzed under a stereomicroscope. During this laboratory analysis of the material, the number of sesame seeds recovered was recorded for each of the test samples. Sample #5206 was subsampled due to the amount of recovered material. This allowed for additional examination into the impact of subsampling on recovery rate and was performed using a riffle box to divide the sample as evenly as possible (Pearsall 2015).

## RESULTS

The flotation recovery test produced high rates of seed retrieval. Both Sample #5205 and Sample #5207 were fully sorted in the laboratory, and all 25 sesame seeds added to each were successfully recovered, indicating a 100% recovery rate for these two samples. Sample #5206, which required subsampling due to the large quantity of recovered material, yielded 12 sesame seeds. Assuming perfect subsampling, an expected 12.5 seeds would represent a proportional recovery, corresponding to a 96% recovery rate. Since partial seed counts are not applicable, this result suggests either complete proportional recovery or, at worst, the loss of one seed. If the latter scenario is assumed, the overall recovery rate across all three test samples would be approximately 98.7%. Minimal physical damage was observed among the recovered sesame seeds, suggesting that the flotation process did not significantly compromise seed integrity. These results demonstrate that the flotation procedures employed by the Slovak Institute of Archaeology, including the SMAP-style machine and subsequent processing, are highly effective and fall well within the acceptable range of performance reported in prior flotation studies (Fig. 3). It is important to note that these prior studies were performed under varying conditions; Pulliam 1986 and Wagner 1982 used similar SMAP-style machines while Hunter/Gassner 1998 and Coward 2022 used more advanced IDOT-style machines. Additionally, Pulliam 1986 and Wagner 1982 used only poppy seeds while Hunter/Gassner 1998 and Coward 2022 incorporated larger seeds in their testing as well.

## DISCUSSION

These results suggest that the flotation machine and associated processing methods used by the Slovak Institute of Archaeology did not negatively impact the recovery of carbonized remains processed by flotation. The seeds were recovered intact, with surface structures visible and seed shape uncompromised. This qualitative visual analysis suggests the flotation process did not negatively impact quality of recovered material. This is especially important to consider as many of the botanical remains recovered from Triblavina are fragmentary in nature.

Modern sesame seeds, like those used in this project, are generally ~2.8 mm in length ~1.5 mm in width and (*Tunde-Akintunde/Akintunde 2004*). This is significantly larger than poppy seeds yet smaller than common Bronze and Iron Age Central European domesticates like wheat (~5.5 mm in length and ~3 mm in width) and barley (~6 mm in length and ~3 mm in Width; *Hajnalová 1989*). They were chosen because they represent a middle point in size between large-seeded grains and small-seeded millets, with a similar size to large wild species. Additionally, they are also easily accessible in large quantities, another key requirement for this kind of testing. Their size may partially account for the exceptional recovery rate despite the clay soil. Smaller seeds like that of poppy are more likely to slip through the screen or be damaged during flotation and generally have lower recovery rates than larger seeds (*Wright 2005*). Future research may choose smaller seeds to test the impact of flotation methods on the recovery of smaller wild or weedy species.

Future applications of similar testing of flotation machines would allow for additional information beyond just the effectiveness of a particular machine. Comparison between machines and methodologies is needed to ensure comparability of results (*Wagner 1982*). Another important area of research is the impact of pre-flotation processing. Certain soils have difficulty breaking down in flotation tanks and are pre-treated to decrease the time needed in the flotation tank. These processes can potentially impact recovery rate and future study of these treatments utilizing this method would be informative (*Wright 2005*).

## CONCLUSION

This study demonstrates that a modified flotation efficacy protocol can be successfully implemented in Central Europe using locally appropriate test seeds. It also provides assurances that flotation process used at the Slovak Institute of Archaeology are capable of achieving recovery rates of up to 98.7%, with minimal seed damage. The use of efficacy testing of flotation machines is an important tool to ensure the process did not significantly impact recovery from the archaeological samples. This study was limited by time and manpower resulting in lower than ideal sample sizes. Future research should ensure that at least 50 or 100 seeds are used in a significant number of samples. Broader implementation of flotation efficacy testing will enhance cross-site comparability and provide critical data on how pre-processing practices affect recovery outcomes

### *Acknowledgments*

This research would not be possible without the generous support of the Slovak Institute of Archaeology, allowing me to assist in the flotation process and analyze the material from Triblavina. I would particularly like to thanks to Jaroslav Wójcik for his help performing flotation. I also owe a great deal of thanks to my advisors, Maria Hajnalova and Katherine Chiou for their help in devising and executing this research. Finally, I would like to thank Eva Hajnalova for her help in the lab assisting with sorting samples. This project was supported by the project VEGA 2/0035/22, Fulbright Slovakia, and a student travel grant from the University of Alabama.

## BIBLIOGRAPHY

- Chiou/Cook/Hastorf 2013 K. Chiou/A. Cook/C. Hastorf: Flotation versus dry sieving archaeobotanical remains: A case history from the Middle Horizon southern coast of Peru. *Journal of Field Archaeology* 38, 2013, 38–53.
- Daňová 2017 K. Daňová: Predbežné výsledky výskumu halštatskej osady v Bernolákove. *Studia Historica Nitriensia* 21, 2017, 357–369.
- Hajnalová 1989 E. Hajnalová: Katalóg zvyškov semien a plodov v archeologických nálezoch na Slovensku. In: C. Ambros/K. Pieta (ed.): *Súčasný poznatky z archeobotaniky na Slovensku*. Acta interdisciplinaria archaeologica VI. Nitra 1989, 3–192.
- Hajnalová 2022 M. Hajnalová: *Archeobotanika*. Bratislava 2022.
- Hunter/Gassner 1998 A. Hunter/B. Gassner: Evaluation of the Flote-Tech machine-assisted flotation system. *American Antiquity* 63, 1998, 143–156.
- Jarman/Legge/Charles 1972 H. Jarman/A. Legge/J. Charles: Retrieval of plant remains from archaeological sites by froth flotation. In: E. Higgs (ed.): *Papers in economic prehistory*. Cambridge 1972, 39–48.
- Kaplan/Maina 1977 L. Kaplan/S. Maina: Archeological botany of the Apple Creek site, Illinois. *Journal of Seed Technology* 2, 1977, 40–53.
- Märkle/Rösch 2008 T. Märkle/M. Rösch: Experiments on the effects of carbonization on some cultivated plant seeds. *Vegetation History and Archaeobotany* 17, 2008, 257–263.
- Miller 2011 N. Miller: Archaeobotanical methodology: Results of an archaeobotany questionnaire. *The SAA Archaeological Record* 11, 2011, 8–10.
- Pearsall 2015 D. Pearsall: *Paleoethnobotany. A Handbook of procedures*. California 2015.
- Pulliam 1986 C. Pulliam: *Flotation Recovery Tests, Old Monroe Project*. Laboratory Notes. Manuscript on file. Columbia 1986.
- Struever 1968 S. Struever: Flotation techniques for the recovery of small-scale archaeological remains. *American Antiquity* 33, 1968, 353–362.
- Tolar et al. 2010 T. Tolar/S. Jacomet/A. Velušček/K. Čufar: Recovery techniques for waterlogged archaeological sediments: a comparison of different treatment methods for samples from Neolithic lake shore settlements. *Vegetation History and Archaeobotany* 19, 2010, 53–67.
- Tunde-Akintunde/Akintunde 2004 T. Tunde-Akintunde/B. Akintunde: Some physical properties of sesame seed. *Bio-systems Engineering* 88, 2004, 127–129.
- Vandorpe/Jacomet 2007 P. Vandorpe/S. Jacomet: Comparing different pre-treatment methods for strongly compacted organic sediments prior to wet-sieving. A case study on Roman waterlogged deposits. *Environmental archaeology* 12, 2007, 207–214.
- Wagner 1982 G. Wagner: Testing flotation recovery rates. *American Antiquity* 47, 1982, 127–132.
- Wagner 1988 G. Wagner: Comparability among recovery techniques. In: C. Hastorf/V. Popper (eds.): *Current paleoethnobotany. Analytical methods and cultural interpretations of archaeological plant remains*. Chicago 1988, 17–35.
- Watson 1976 P. Watson: In pursuit of prehistoric subsistence: a comparative account of some contemporary flotation techniques. *Midcontinental Journal of Archaeology* 1, 1976, 77–100.
- Wright 2005 P. Wright: Flotation samples and some paleoethnobotanical implications. *Journal of Archaeological Science* 32, 2005, 19–26.

## UNPUBLISHED SOURCES

- Coward 2022 E. Coward: *Paleoethnobotany at Wanuskewin Heritage Park: Plant Use at the Red Tail (FbNp-10) and Wolf Willow (FbNp-26) Sites and An Evaluation of Macrobotanical Flotation Techniques*. Masters Thesis. University of Saskatchewan. Saskatoon 2022. Unpublished.

## Testovanie účinnosti preplavovacích systémov pomocou cielene vkladáných semien

### Prípadová štúdia z Triblaviny, sídliska zo staršej doby železnej na Slovensku

C a l e b R a n u m

#### Súhrn

Táto práca je inšpirovaná „*testom makových semien*“, používaným v paleoetnobotanických štúdiách v Amerike, a zameriava sa na hodnotenie účinnosti dvojfázovej flotácie, ktorá kombinuje flotáciu v zariadení typu SMAP s manuálnym preplavovaním. Na overenie tohto postupu bolo počas preplavovania archeobotanických vzoriek z lokality staršej doby železnej v Triblavine do troch vzoriek pridaných 25 zuhoľnatených semien sezamu. Preplavovanie sa uskutočnilo v Archeologickom ústave SAV, v. v. i.

Laboratórne analýzy ukázali mieru zachytenia vložených semien až do 98,7 % pri minimálnom poškodení semien. Výsledky naznačujú, že flotácia kombinujúca preplavovanie pomocou preplavovacieho zariadenia a manuálne metódy, vyvinutá pre Archeologický ústav Slovenskej akadémie vied Máriou Hajnalovou, zabezpečuje mimoriadne efektívnu extrakciu archeologických makrozvyškov rastlín z analyzovaných vzoriek.

Hoci bol tento test limitovaný časom a kapacitami ľudských zdrojov, poskytuje cenné východisko pre budúci výskum a ďalších bádateľov. Rozšírené uplatnenie tejto techniky by umožnilo presnejšie porovnanie medzi lokalitami a mohlo by prispieť k lepšiemu pochopeniu vplyvu rôznych typov usadenín, ako aj (pred)úprav vzoriek, na mieru zachytenia rastlinných makrozvyškov.

Obr. 1. Flotačný systém typu SNAP používaný Slovenským archeologickým ústavom na preplavovanie vzoriek z Triblaviny.

Obr. 2. Ručné preplachovanie ťažkej frakcie pomocou vedrového systému.

Obr. 3. Porovnanie miery zachytenia z lokality Triblavina s výsledkami štyroch ďalších štúdií, ktoré vykonali „*test makových semien*“ alebo jeho modifikovanú verziu.

Preklad súhrnu Alena Bistáková s deepL.com

M.A. Caleb Ranum  
University of Alabama  
801 University Boulevard  
AL – 354 01 Tuscaloosa  
cranum@crimson.ua.edu  
<https://orcid.org/0009-0001-3122-2066>

and

Univerzita Konštantína Filozofa v Nitre  
Filozofická fakulta  
Katedra archeológie  
Hodžova 1  
SK – 949 01 Nitra

