Morphometric Analysis of the 18th Century *Vitis sp.* Seeds from *Apulum* Archaeological Site

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Abstract

The present study examines *Vitis sp*. seeds discovered during the excavations in 2017 on an archaeological site in *Apulum*, the current city of Alba Iulia, Romania. The archaeological context was dated as belonging to the 18th century. The grape seeds were measured in order to determine whether they are cultivated or wild. Using mathematical formulas and keys given for interpretation, all the seeds were determined as being cultivated. The results obtained complete the archaeological information regarding *Vitis sp*. use in human diet during Modern era in Transylvania.

Keywords: archaeobotany, macroremains, Modern era

Introduction

Vitis is a genus that appears among the oldest fossils discovered in the current Arctic and cold temperate areas in northern hemisphere. Climatic conditions during the glacial periods have led to the disappearance of other genera and species belonging to the *Vitaceae* family in Europe as well as Central and Western Asia (Teodorescu *et al.*, 1966). Romania has a few millennia-old winegrowing culture and good conditions for viticulture (Popa *et al.*, 2006). The idea is supported by numerous archaeological finds, like tools for maintaining a vine plantation, containers for wine transportation and storage, funeral monuments with vine representations, and also by paleoethnobotany.

Paleoethnobotany studies the vegetal remains recovered from archaeological sites and the human-plant relationship. This term was introduced in 1950 by the Danish scientist Hans Helbaek and is used to describe vegetal macroremains (Ciută, 2009). Depending on the geographic area, the macroremains can be found in several conditions: charred remains, intentionally burnt, indirectly burnt (i.e., near an oven) or accidentally burnt (i.e., in the brick making material); printing parts of the plant in ceramics, plaster or bricks; macroremains preserved by dehydration (i.e., in tombs, clay); plant remains preserved in environments with constant humidity (i.e., wells); remains preserved in the presence of toxic metal oxides (i.e., metallic oxides of bronze); siliceous and calcareous inlays (Ciută, 2009).

In Romania, most of the remains were identified in the extra-Carpathian region and they date between Aeneolithic period, Precucuteni culture (Monah, 2005), and the Byzantine period (Cârciumaru, 1996). In Alba Iulia, grape seeds and dehydrated berries belonging to the Roman era were found in some ritual pits near the temple of *Liber Pater* (Ciută, 2010). The recent finds in Alba Iulia confirm once again that the

Figure 1. (1) Aerial view of the archaeological site; (2) Detailed view of the sections (Călin Şuteu)

Figure 2. Detailed view of the remains of the winepress: the river stone foundation and wooden beam fragments. The seeds were collected from the dark area visible on the bottom left side of the image. (Florin-Ovidiu Botiş)

area has a tradition in wine making and that a multidisciplinary approach is needed in order to do a complete research in an archaeological site.

Materials and methods

The grape seeds used in this study were discovered during the excavations in 2017 on the archaeological site *Apulum*, the "Governors' *praetorium* of Roman Dacia", in section S XX/16 (Fig. 1). A sample was collected from a 10-15 cm layer of grape seeds, placed on the remains of a supposed winepress (Fig. 2). The layer in which the seeds were found was at -1.50 m depth. The archaeological context was dated according to the coin of empress Maria Theresa (1740-1780), found on the winepress.

From the sample received, a total of 404 grape seeds were selected. A morphometric analysis was carried out on the best-preserved seeds using an OPTIKA stereomicroscope with an Optikam PRO 5 Digital Camera attached on it. The measurements taken on the dorsal side of the grape seeds were the following: length of stalk (LS), position of the chalaza (PCH), total length (L) and total width

Figure 3. Dorsal image of seed number 11, with the measurements taken, where LS = length of stalk, PCH = position of chalaza, L = total length, B = total breadth. Scale in mm. (Iulia-Alexandra Farcaș)

Table 1. Keys for the formulas used in the current study.

Formula 1	**Formula 2**
A < -0.2 → wild seeds	A < -0.2 → wild seeds
A > 0.8 → cultivated seeds	A > 0.9 → cultivated seeds
A [-0.2, 0.2] → 64.7% cultivated seeds	A [-0.2, 0.4] → 90.1% cultivated seeds
A [0.2, 0.8] → 76.2% cultivated seeds	A [0.4, 0.9] → 63.8% cultivated seeds
Formula 3	**Formula 4**
A < 0 → wild seeds	A < -0.9 → wild seeds
A > 0.9 → cultivated seeds	A > 1.4 → cultivated seeds
A [0, 0.5] → 93.3% cultivated seeds	A [-0.9, 0.2] → 91% cultivated seeds
A [0.5, 0.9] → 63.3% cultivated seeds	A [0.2, 1.4] → 76.5% cultivated seeds

(B) (Fig. 3). The following formulas proposed by Mangafa and Kotsakis (1996) were used to distinguish between wild and cultivated grape seeds:

Formula 1: -0.3801+(-30.2 × LS/L+0.4564 × PCH-1.386 × L+2.88 × PCH/L+9.4239 × LS)

Formula 2: 0.2951+(-12.64 × PCH/L-1.6416 × L+4.5131 × PCH+9.63 × LS/L)

Formula 3: -7.491+(1.7715 × PCH+0.49 × PCH/L+9.56 × LS/L)

Formula 4: 0.7509+(-1.5748 × L+5.297 × PCH-14.47 × PCH/L)

The formulas have been successfully applied to various grape seeds found in archaeological sites, dating between the Late Neolithic and Early Bronze Age (Valamoti *et al.*, 2007; Valamoti, 2015) and between Antiquity and Middle Ages (Güner *et al.*, 2009).

The values obtained in the current study were interpreted using the keys shown in Table 1, where "A" is the value obtained (Mangafa and Kotsakis, 1996).

To characterize the sample, box plots were created and Pearson correlation was used to

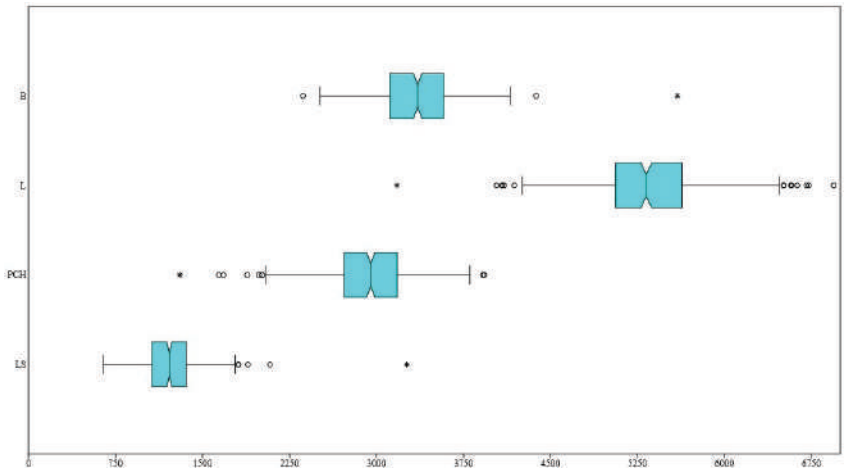

Figure 4. Boxplot generated using PAST, where o = values outside the "inner fences", * = values outside the "outer fences"

Table 2. *r* values for the measured parameters

	LS	PCH	L	B
LS		0.54983	0.52105	0.18718
PCH	0.54983		0.76822	0.074263
L	0.52105	0.76822		0.33863
B	0.18718	0.074263	0.33863	

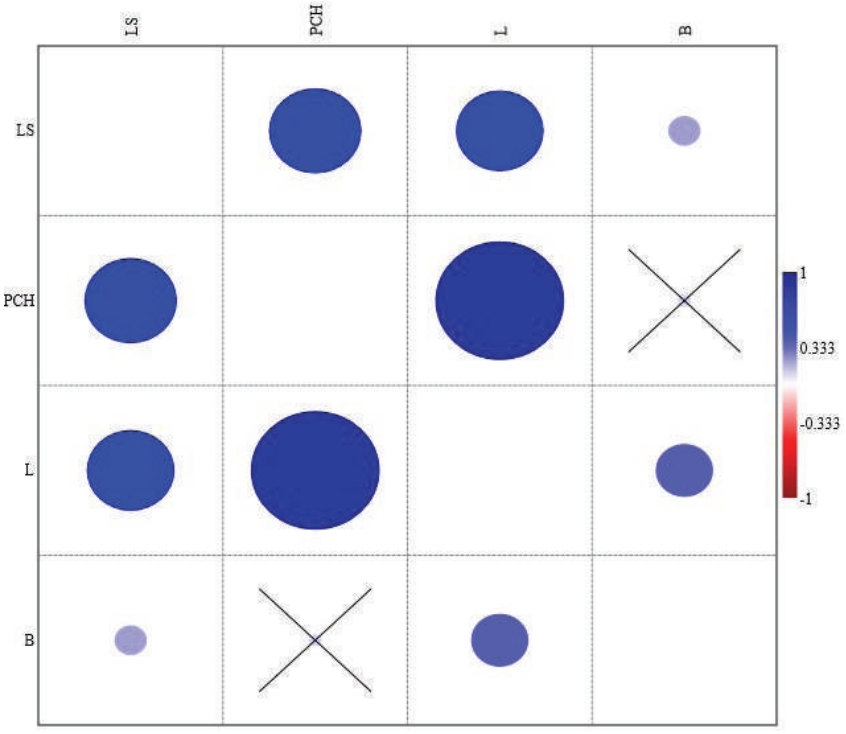

Figure 5. Pearson correlation plot generated using PAST, where p>0.05 crossed

determine the relation between the measured parameters. The statistical analysis was performed using PAST, a free software for scientific data analysis.

Results and discussions

Combining the results obtained using the four formulas, all 404 grape seeds were determined as being cultivated. Using the second formula it can

be noticed that three grape seeds had only a 63.8% chance of being cultivated. Mangafa and Kotsakis (1996) suggest the use of the second and third formulas for the identification of archaeological grape seeds, but they also note that the overall results are more or less the same.

The sample can be characterized as being heterogenous (Fig. 4). Further statistical analysis is needed to establish in how many groups can the seeds be divided.

A positive correlation can be observed between most of the parameters, especially between the total length of the seed (L) and the position of the chalaza (PCH), where the correlation is strong (Tab. 2 and Fig. 5). In this phase of the study, the existence of a strong correlation does not suggest a link between the two parameters. It can't be insinuated that L determines PCH or vice versa.

The remains of a supposed wine press and the grape seeds found in the same context suggest the production of wine for personal use or in commercial purposes. The studied sample apparently didn't preserve seeds with pulp and/ or skin attached to them, but most of the seeds were covered with a black film. This characteristic must be further investigated to establish if the depositional factors might have affected the grape seeds colorimetry.

Conclusion

A multidisciplinary approach of the studied material is necessary for a better understanding of the social, cultural and economic context of the archaeological finds. The grape seeds were well preserved and allowed the obtaining of precise morphometric determinations that once analyzed complete the archaeological information regarding *Vitis sp*. use in human diet during Modern era in Transylvania. All the 18th century grape seeds analyzed were determined as being cultivated using four formulas proposed by Mangafa and Kotsakis (1996). A further research is necessary for establishing the number of groups in which the seeds can be divided in and for comparing the 18th century grape seeds to those from modern collections.

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