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A STATISTICAL APPROXIMATION OF COMMON ROMAN CERAMICS FROM THE ISTURGI DEPOSITS (ANDÚJAR, ANDALUSIA)

1. Introduction[1]

In the archaeological record of Roman excavations the most abundant material is constituted by common ceramics, particularly those fragments made using very simple technology, and which may occasionally be somewhat coarse in appearance. For this reason the range of vessels designed for the production, serving, storage and transportation of food has got the name of coarse-ware ceramics. These archaeological remains have been underestimated compared with high-quality Roman ceramics, the terra sigillata that, for its characteristics of delicacy and beauty, has traditionally monopolized the attention of researchers. Nevertheless, nowadays common ceramics are considered to be a fundamental historical source for the knowledge of daily life in the Roman period.

Disciplines such as archaeometry are focused on an analysis of the origin of the clay used in the manufacture of the vessels, which, from an examination of literary sources, helps us to understand the purpose of these containers, which have become likewise indispensable to approach a reconstruction of daily life (Fernández-García 1999, 2004; Fernández-García, Morales de la Cruz 2007; Fernández-García, Ruíz-Parrondo, Ruíz-Montes 2007; Fernández-García, Roca 2008).

In the ancient province of Baetica seven ceramic production centers had been identified belonging to the Roman period, located essentially in the south-eastern part of the region (Fig. 1).

The quantity of forms that appear in a deposit, or in a zone, depends largely on the zone itself. Limiting ourselves to the Isturgi area, they can be divided into coarse pottery and thin-walled pottery, although they are customarily divided into three groups:

a) Kitchenware. Ceramic vessels used in culinary preparations, regardless of other possible secondary purposes. Their use facilitated the production of food in cold vessels (mortars), or their exposure to fire for food with specific caloric intake needs. This is the case of the pots, plates, tripods, mortars and lids which frequently show signs of soot on their surfaces.

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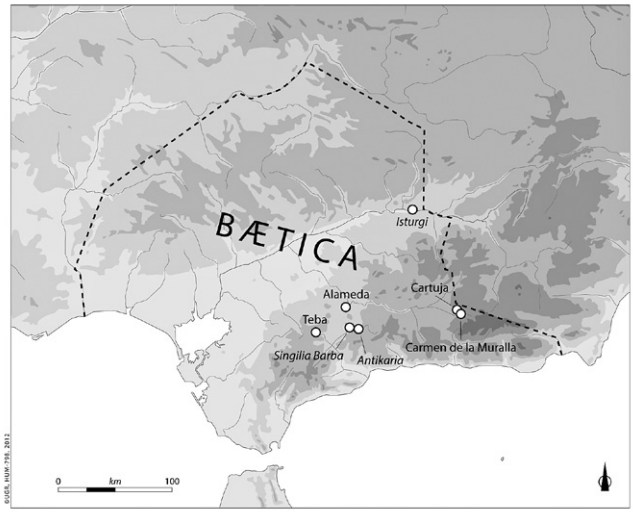

Fig. 1 – Producers of terra sigillata hispanica.

b) Tableware. These vessels were used to contain food after its production, and they include utensils for serving liquids (flasks and pitchers), for eating and drinking (cups), or for performing both functions together (bowls).

c) Storage and transportation vessels. These include the large ceramic containers designed to contain solid products (dolia, and very large pots) or liquids (pitchers) (Amante 1984; Bermejo 2011).

Firing consists of the process of transformation of the clay minerals by means of the application of a high temperature, which provides properties that are definitive. Firing in an oxidizing atmosphere requires a good air inlet with oxygen in excess in the firing chamber. The resultant ceramics will have a coloration from reddish to ocher.

In a reducing atmosphere, there is a lack of oxygen inside the firing chamber, which removes oxygen from the ceramic fabric, producing pottery with coloration ranging from gray to black.

Also, the technology is designed to heat the material at least to 600º, to turn the ceramics into a hard and durable product. Alhough there are various kinds of kilns, they can be classified into three basic types: two of them correspond to prehistoric periods and protohistoric kilns dug into the ground, and the third is a kiln type that began to be used as of the later Iron Age.

In this work, common pottery from the Isturgi deposits (Andújar, Andalusia) is analyzed from the point of view of having been made in oxidizing or reducing atmospheres.

2. Materials and methods

The pottery from the Baetica Region, with reference to centers of ceramic production, is analyzed on the basis of oxidizing and reducing characteristics. The main forms are cooking pots, tripods, covers, pitchers, beakers, dishes, mortars, flasks, concave vessels, and dolia that constitute a typical kitchen assemblage. From an analytical point of view, the material will be analyzed by means of statistical analyses to determine important aspects such as the distribution of the forms, whether the pottery can be ascribed to an oxidizing or reducing atmosphere, the relationship between the forms, the correlations between them, etc. (Fig. 2).

3. The ceramics of Isturgi

The data set consists of 3,626 fragments of Roman ceramics, divided into three clearly differentiated groups: 1) common calcareous ceramics, 2) oxidized kitchen ceramics, and 3) reduced-fired kitchen ceramics, although with very different numbers of fragments (1,635, 1,714 and 277, respectively) distributed into excavation units which are assigned to one of these three previous categories, and the typology of the ceramics. The percentages for each category are 45%, 47% and 6% respectively, thus showing an important polarization in the data set (Ruiz-Montes 2007) (Fig. 2).

Differences between the quantity of fragments and classes is very well-known. First, the common calcareous ceramics are distributed fairly evenly

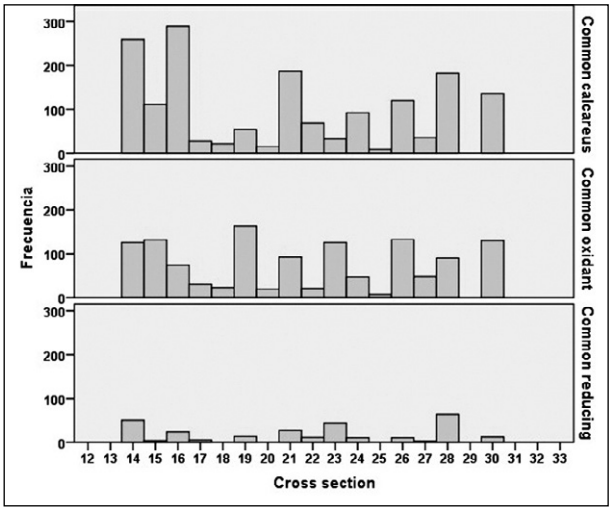

Fig. 2 – Fragments of common calcareous ceramics reducer.

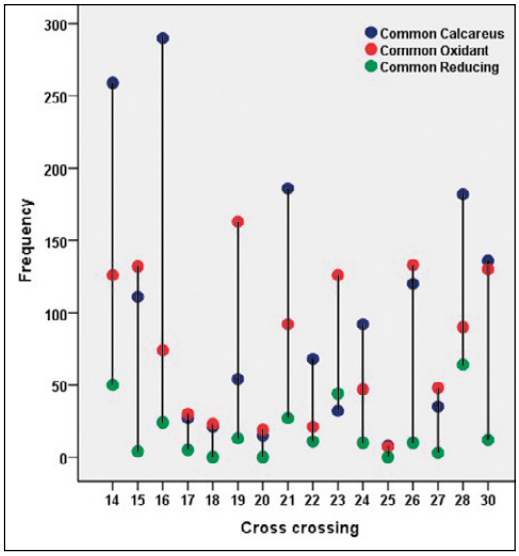

Fig. 3 – The abandon of reducing ceramics in favor of the oxidizers ceramics.

across the settlement, although the units of excavation emphasize 14, 15 and 16, as well as 21, 26, 28 and 30. If the numbering of the units of excavation indicates some relation, the cuts 14, 15 and 16 indicate a great density of remains of calcareous common ceramics, probably due to a major production zone, or a dump of defective or waste material, together with other zones with fairly minor density (zone 7 or zone 12). Accordingly, whereas in zone 1 the excavation unit contains a medium quantity distributed of regular form, in excavation unit 2 the number of fragments is fairly minor, although the unit of excavation appears three times than nº 18 whereas in nº 3 all units of excavation except nº 23 appear of almost nominal form.

The distribution of the material for courts shows an important change between them that are an indication of the processes which took place in the functioning of the structures of production and commercialization, with all that this implies from the socio-economic point of view. Thus, the process of manufacture is abundant in common calcareous ceramics and in oxidized kitchenware, probably indicating that reduced kitchen ceramics constitute a declining, older model in these ceramics. Also, the massive presence of products made from Hispanic terra sigillata seem to dominate the pottery production, marking a divide between the differing markets which these products were intended for, and the routes they took: either by waterway towards the Atlantic Ocean, or along the Via Augusta. All this contributed to the enormous

	Square sum	gl	Quadratic average	F
Inter-Grupos	6118474.483	2	3059237.241	607.947
Intra-Grupos	14143824.963	3102	4559.583	
Total	20262299.446	3104		

Tab. 1 – ANOVA one factor.

					Confidence interval	
Var(i)	Var(i)	Diff. (I-J)	Mean error	Sig	Low limit	Upper limit
1	2 3	67.97355 135.86175	2.57300 4.36726	.000 .000	61,8105 125.5321	74,1366 146,4537
2	1 3	-67.97355 67.97355	2.57300 4.48506	.000 .000	-74.1366 57.2763	-61,8105 78,7623
3	1 2	-135.86175 135.86175	4.36726 4.48506	.000 .000	-146.4537 -78.7623	-125,5321 -57,2763
Mean difference is significant α<0.05						

Tab. 2 – ANOVA three factors.

diffusion of the *sigillatae isturgitanas* which displaced, with considerable force, the products made previously, a sigillata which was undoubtedly desired by the indigenous elites, as symbols of prestige and representation.

The creation to graph two or more summarizes two or more variables inside the categories of another variable. The clear relationship between the different classes, common oxidized ceramic and reduced ceramics, shows that the workshops radically abandoned the manufacture of this ceramic in favor of oxidized ceramics. The analysis of the correlation coefficient between the three more usual types of ceramics shows a clear separation between the types of ceramics (Fig. 3).

Although there is a clear difference between the three types, the quantification of the aforementioned difference is fundamental, since it allows us to establish the existence or otherwise of statistically significant differences between them. Using the procedure of analysis named ANOVA of a factor, an analysis of variance is produced with regard to the only variable of factor or the independent variable by means of a Student's t-test. This analysis determines that the differences between the averages exist, and allows us to compare two types of contrasts between averages: a priori and a posteriori test (the Levene post hoc test for differences, and the Bonferroni test to analyze mean differences between variables) (Tables 1 and 2).

Analysis of variance is used for confirming the hypothesis according to which several averages are equal or not, and an extension of the Student's

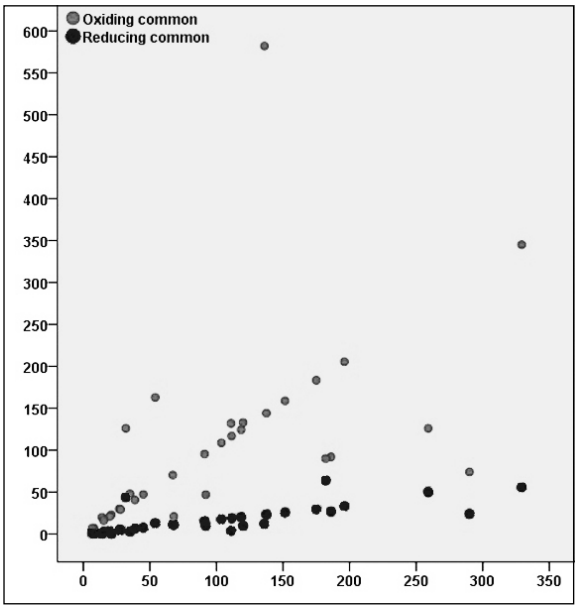

Fig. 4 – Division between ceramic oxidizers and reducing.

t-test for two samples for determining that differences between the averages exist, thus enabling us to know what averages they defer. First, it is necessary to conduct different post hoc tests, such as the Bonferroni test, Sidak, Tukey's truly significant difference, GT2 of Hochberg, Gabriel, Dunnett, Ryan-Einot-Gabriel-Welsch tests, (R-E-G-W F), Ryan-Einot-Gabriel-Welsch's range tests (R-E-G-W Q), T2 of Tamhane, T3 of Dunnett, Games-Howell, C of Dunnett, test of multiple range of Duncan, Student-Newman-Keuls (S-N-K), test of Tukey, Waller-Duncan, Scheffé and less significant difference (Sokal, Rohlf 1982; Venables, Ripley 2002; Orton, Hughes 2013; Fernández 2015). In our case, the Bonferroni test has been used, with the results in Tables 1 and 2.

The results show that three groups exist with statistically significant differences, although with major differences between them. The differences between groups 1 and 2 are average, indicating that there may be an overlap between both groups. Nevertheless, the separation between groups 1 and 3, and also between groups 2 and 3, show very different characteristics, because membership of these groups is a key element with respect to the ceramics. Thus, the differences between the oxidized and reduced fabrics are totally distinguishing, which allows us to carry out a more exhaustive classification, as appears in a more rigorous examination allowing the creation of an initial classification (Fig. 4).

4. Macroscopic analysis

Macroscopic analysis has allowed us to identify different types of pottery, reduced or oxidized, depending on various characteristics such as color, texture, the size of the opening, surface finish etc. In addition, the analysis of these data allows us to propose the first approximation to the classification of principal types of fabric documented in common kitchenware, tableware and storage ware in the region during the early imperial period:

– *Type I*. This type is produced by means of irregular firing reduction, and with poor control of firing temperature. In many cases, the fragments display very irregular sections with two colors, and a "sandwich" effect. Pottery often has a size greater than 1 mm, and habitually contains refractory components, and its surface is very rough, with coloration similar to Munsell tone N2 2/1. Most ceramics of this type have been documented in pots and casseroles for cooking, and they may correspond to the type of fabric called "common sedimentary ceramics of unglazed pottery" recorded in a recent study on ceramic contexts documented in the Lagunillas (Centeno, Palomino, Villadangos 2010).

– *Type II*. This is a type of fabric fired in a reducing atmosphere, but more regular than the previous ones, having pottery normally less than 1 mm. The texture of this pottery is rough and relatively powdery, and its coloration ranges between 10 YR 3/6, 3/7, and 3/8. The great majority of similar fabrics belong to containers such as dolia, designed for the storage of large quantities of food. Some of the features described above might relate to the correspondents to the type of fabric called "common ceramics of sedimentary unglazed pottery" documented in Las Lagunillas (Centeno, Palomino, Villadangos 2010).

– *Type III*. This type of pottery is produced when the reducing atmosphere is more regular, with filler of small size. The texture of these sherds is smooth, and in some cases they have a very thin glaze. They are usually shiny black, with similar tones to Munsell N2 2/2.

– *Type IV*: These are fragments exposed to an irregular oxidizing atmosphere (a great variety of monochrome, two-color and "sandwich"-type sherds are recorded) with small size and smoothed. They tend to be of orange color, of type Munsell 7,5 YR 6/8. This type of ceramic has similar features to those recorded in the contexts of Las Lagunillas (Centeno, Palomino, Villadangos 2010), and parallels have been proposed in Quintanilla (Illarregui, Puente 2000, 142) or in Adaja (García, Sanchez 2003, 121).

– *Type V*: These are pieces fired in a regular oxidizing atmosphere. They are small and often generate exudation of calcareous or saline type. The texture of the pieces is very smooth, and the colorations mostly present varieties

between beige type Munsell 5 YR 6/8-6/9 and other pieces, and grayish, possibly corresponding to the F-type fabric of Quintanilla's common ceramics (Illarregui, Puente 2000, 123).
– *Type VI*: Smooth fabrics fired in a very regular oxidizing atmosphere that is in the habit of including filler of almost imperceptible size, with colorations that tend to be closer to pinkish tones very similar to Munsell 10 R 8/5.

It is necessary to specify that the variations in the coloration, within each of the types of fabric, do not show thermal differences during the firing process in the kiln or due to the use of differing types of clay. In a recent study by Peinado (2010, 384), it was shown that the chromatic variations in this type of ceramics led to the same outcome as was produced as a result of differing conditions produced in the processes of cooling. Experimentation with similar potters' kilns has made it possible to reject a direct relationship between the coloration and the finished ceramic product, and the thermal variations seen during firing (Raposo *et al.* 2013).

5. Multivariate data analysis

Factorial data analysis tries to identify underlying variables, or factors, which explain the configuration of the correlations inside a set of observed variables. Factorial one is used to reduce the information identifying a small number of factors or new variables that explains the majority of the variance observed in a minor number of manifest variables. Also it can be used for generating hypotheses relating to the causal mechanisms, or to investigate variables for subsequent analyses (for example, to identify colinearity before conducting an analysis of linear regression).

Its application to these data provides two Principal Components, having 66.822% of variance in the first component and 20.515% in the second component, thus obtaining 87.337% of total joint variance that comprises the 1 and 2 factorial plans (Orton 1982; Sokal, Rohlf 1982; Venables, Ripley 2002; Orton, Hughes 2013; Fernandez 2015) (Table 3).

Though several criteria exist to carry out a factorial analysis, the most common ones are:

– Varimax Criterion. This is a usual method that uses orthogonal rotation to minimize the number of variables that have high saturations in every factor. It simplifies the interpretation of the factors.
– Quartimax Criterion. This is a method of rotation that minimizes the number of necessary factors to explain every variable, and simplifies the interpretation of the observed variables.

In this case, the varimax criterion has been applied to all the data, with the following results (Table 3). It is clear that two groups of information exist.

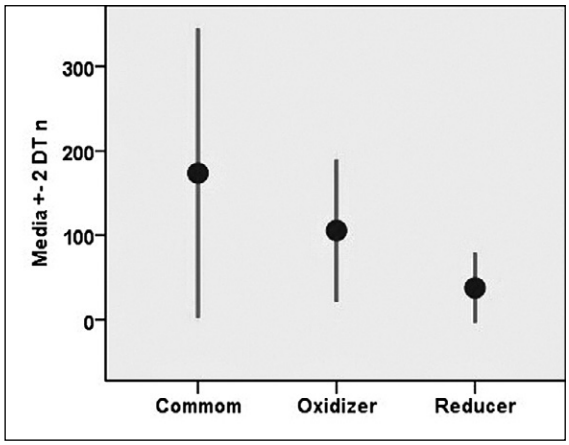

Fig. 4 – Discrimination between common, oxidizer and reducer ceramics.

Component	Initial Values		
	Total	% Variance	% Acumulated
1	2.005	66.822	66.822
2	.615	20.515	87.337
3	.380	12.663	100,.000

Tab. 3 – Factorial Analysis. Varimax rotation two factors.

6. Conclusions

A great variety of containers and kitchen utensils (made of ceramic, bronze or iron) were used in the Roman kitchen. In many cases, their design does not differ much from modern designs. From the Celtic tradition the most usual forms are the large cauldrons that were suspended over a fire by means of chains, and that were in use especially in the field. Bronze jars were frequent in the kitchens of the higher classes, but the use of ceramic jars, more economical and with a great variety of shapes, became very widespread and popular.

The presence of common manufactured ceramics is frequent in the whole Atlantic area and, in general, in the peripheral regions of the Roman empire during the 2nd century and, especially, the 3rd century AD. This represented a return to the use of handmade vessels in urban and rural contexts, while, on the other hand, these must never have disappeared completely. The differences between the amount of fragments between classes is very

well-known. As already mentioned, common calcareous ceramics are evenly distributed fairly in the deposit, though the cuts emphasize 14, 15 and 16, as well as 21, 26, 28 and 30. If the number of cuts indicates some relation, cuts 14, 15 and 16 indicate a great density of remains of calcareous common ceramics, probably due to a zone of great production, or a dump of defective or waste material, together with other zones of fairly minor density (zone 7 or zone 12).

In addition, a graph allows us to summarize two or more variables within the categories of another variable. This relationship shows the different cuts and the condition of common ceramics, oxidizing and reduced ceramics, showing that the workshops radically departed from the manufacture of reduced ware in favor of oxidized ware. This division between oxidized and reduced ceramics indicates the great differences between both types of ceramic, and the gradual replacement by oxidized ceramics (Fig. 5).

Also, the data must have a normal bivariant distribution for every pair of variables and the observations must be independent. The factorial model of analysis specifies that variables are determined by the two principal common factors (the factors estimated by the model) and by the other factors (which are not superimposed between the different observed variables). The calculated estimations are based on the supposition that all the factors are not correlated between them. The use of the two first principal components allows us to detect a structure factor of almost 90% with minimum loss of data, showing a clear structural stability.

The matrix of rotated components, by means of the varimax criterion, divides the factors into two blocs. The first one comprises common and reduced ceramics, and the second one comprises oxidized ceramics, which were taking over. Data reduction has two purposes: a) to remove redundant variables from the data file, perhaps replacing the entire data file with a smaller number of uncorrelated variables between them but having great eigenvalues, and b) the detection of structures to obtain the underlying (or latent) relationships between the variables (Table 3).

The transportation of objects over long distances was achieved preferably by waterways or maritime transport, due to the fact that common ceramics served to complete the load of ships destined for the transport of agricultural or mineral products, and constituting the return freight of cups, terra sigillata and amphorae. This trade between Italy and the provinces of the Empire was maintained throughout the 1st century AD. Also, these became adopted by the inhabitants of the newly conquered provinces as part of their own household belongings, and they mixed them in their kitchens with traditional forms. Finally the massive arrival of legionaries in the Iberian Peninsula, on the occasion of the Civil wars, originated a wide demand for products, including the forms needed for the preparation of two of the most typical dishes

in the Roman diet: sauces, and tortillas based on eggs, that could present a multitude of variants.

The presence of common handmade ceramics proves to be fairly frequent in the whole Atlantic area and, in general, in the peripheral regions of the Roman empire during the 2nd century. The 3rd century A.D, especially, witnessed a return to the use of handmade vessels in urban and rural contexts that, however, must never have disappeared completely.

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ABSTRACT

Common ceramics constitute a very abundant material in the archaeological record. This study focuses on analyzing and statistically interpreting, from the perspective of archaeological material culture, the features of Roman coarse-ware ceramics from the Isturgi deposits (Andújar, Andalusia). The main goal of this research was to study ceramics from an archaeological perspective with reference to quantitative and qualitative aspects. The fragments of pottery belong to three essential types – kitchenware, tableware, and pottery for storage and transportation – and have different characteristics. The data set consists of 3,626 fragments of ceramics of Roman origin, divided in three clearly differentiated groups: 1) common calcareous ceramics, b) oxidized kitchen ceramics, and 3) reduced kitchen ceramics, having a very different quantity of fragments (1,635; 1,714; and 277, respectively) distributed in 16 excavation zones. The analysis of the information has been carried out on the basis of univariate methods, analysis of correlation and regression, analysis of the variance (ANOVA) and multivariate factorial analysis (Factorial Analysis with Varimax Rotation mainly). In this form it is possible to characterize ceramics on the basis of whether they were fired in an oxidizing or a reducing atmosphere.