MICROSCOPIC ANALYSIS OF BOTANICAL RESIDUES FROM CERRO ESMERALDA BURIAL IN NORTHERN CHILE: STATE AND DEATH RITUAL IMPLICATIONS

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SUMMARY

In this paper we examine five offerings from a funeral context found at Cerro Esmeralda, an Inca burial ground in the Iquique coast of northern Chile. We focus on the identification of utilized plants, and investigate the consumption of chicha *during this mortuary ritual. We brushed and scraped* aríbalo *vessels and* chuspa *bags with sterile lab tools and collected and analyzed micro-samples for starch and phytoliths. We identified* Zea mays *starch,* Cucurbita *sp./*Lagenaria *sp.,* Phaseolus *sp., and a few grains of* Manihot *starch. The identified phytoliths that were present include festucodeae, dicotyledons, and graminoids. These results and this context suggest the consumption of high-quality chicha in the Inca regional funeral setting. Several possible interpretive scenarios are suggested, including the use of various types of plants to optimize the maize fermenting process; ritualistic consumption of* chicha *to feast with the dead (*comer con el muerto*); ancient anthropogenic contamination of the vessels due to different types of daily uses; and, finally, as social and ritual activities associated with all these possible scenarios.*

Introduction

During the *Tawantinsuyu* or Inca Empire, *chicha* (corn beer) consumption, politics, and human sacrifices were intimately intertwined with reciprocity, alliances, and hospitality, which were key components of the Inca state's goals of conquest, control, and expansion (Morris, 1974; Morris and Thompson, 1985; Dillehay, 2003; Morris and Covey, 2003; Bray, 2009; Morris *et al*., 2011). One of these types of human sacrifices was the *Capacocha* rituals described by several chroniclers of the Andean region (Molina 1943 [1575], Guamán Poma 1980 [1615], Cobo 1990 [1653], Betanzos 1996 [1557], Sarmiento de Gamboa, 2007 [1572]). Their ethnohistorical accounts correlate with archaeological records (Mostny, 1957; Reinhard, 1999, 2005; Chávez, 2001; Ceruti, 2003a, b; Cummins, 2004; Bray *et al*., 2005; Bray, 2009). These human sacrifices were performed in commemoration of historical events in the life of the Inca emperor or in response to natural catastrophes, whereas the provinces of the *Tawantinsuyu* were socially and politically linked to the Cusco capital through this practice of human sacrifice (Cobo, 1990; Ceruti, 2003b; Reinhard and Ceruti, 2010; Andrushko *et al*., 2011). A *Capacocha* site has been characterized as having the following inhumation archaeological features: a) the sacrifice of one or several children of both sexes; b) burials in an important Andean mountain peak or special regional place; c) large and lavish ceramic grave goods (*aríbalos* among others); d) fine clothes/garments (*cumbi* among others); e) miniature *Spondylus* sp., silver and gold anthropomorphic figurines decorated with exotic feathers and clothes in addition to miniature camelids made of the same type of metals; f) exotic goods such as feathers, cinnabar pigment, and *Spondylus* shells; g) food offerings such as *chuspa* bags with coca leaves and edible products (e.g., jerky, corn). Along with the mentioned features, the fermented maize drink called *chicha* was prepared for this ritual (Molina, 1943; Guamán Poma, 1980; Cobo, 1990; Betanzos, 1996; Ceruti, 2003a, b, 2015; Cummins, 2004; Bray *et al*., 2005; Sarmiento de Gamboa, 2007; Bray, 2009; Reinhard and Ceruti, 2010; Wilson *et al*., 2013).

Today, about 18 of these sites have been discovered, many showing the presence of *aríbalos* or vessels to store and transport *chicha*. *Capacocha* sites from the high Andean mountains, 6000masl, include Cerro Ampato in the Colca

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ANÁLISIS MICROSCÓPICO DE RESIDUOS VEGETALES DEL SITIO DE CERRO ESMERALDA, NORTE DE CHILE: ESTADO E IMPLICACIONES ACERCA DEL RITUAL FUNERARIO

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RESUMEN

En este trabajo se estudian cinco ofrendas del contexto fúnebre Inca de Cerro Esmeralda, Iquique, costa norte de Chile, con el propósito de contribuir a identificar los tipos de plantas utilizadas y en particular ahondar en el estudio del consumo de chichas asociado a este ritual mortuorio. Utilizando técnicas de raspado y cepillado con elementos estériles se extrajeron muestras de sedimentos de jarras y chuspas ofrendadas para análisis de almidones y fitolitos. Se logró identificar almidones de Zea mays*,* Cucurbita *sp./*Lagenaria *sp.,* Phaseolus *sp. y un grano de posible* Manihot*. En cuanto a los fitolitos, los principales hallazgos incluyen la presencia de festucodies, dicotiledóneas y gramíneas. Estos datos y su contexto sugieren el consumo de* chicha *de buena calidad en un escenario Inca regional. Se presentan varios escenarios de interpretación como por ejemplo el uso de diferentes materias primas vegetales para optimizar la fermentación, un uso ritualístico de 'comer con el muerto', posible contaminación antrópica ancestral de las vasijas durante varios usos cotidianos y, por último, actividades sociales y rituales asociada al conjunto de estos probables escenarios.*

ANÁLISE MICROSCÓPICO DE RESÍDUOS VEGETAIS DA ÁREA DE CERRO ESMERALDA, NORTE DO CHILE: ESTADO E IMPLICAÇÕES SOBRE O RITUAL FUNERÁRIO

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RESUMO

Neste trabalho são estudadas cinco oferendas do contexto fúnebre Inca de Cerro Esmeralda, Iquique, costa norte do Chile, com o propósito de contribuir para identificar os tipos de plantas utilizadas e em particular aprofundar o estudo do consumo de "chicha" *(bebida típica da região), associado a este ritual mortuário. Utilizando técnicas de raspagem e escovado com elementos estéreis se extraíram amostras de sedimentos de jarras e* "chuspas" *(bolsas de lã) oferendadas para análise de amidos e fitólitos. Se conseguiu identificar amidos de* Zea mays, Cucurbita *sp./*Lagenaria *sp.,* Phaseolus *sp. e um grão de possível* Manihot*. Quanto aos fitólitos, as principais descobertas incluem a presença de festucoides, dicotiledóneas e gramíneas. Estes dados e seu contexto sugerem o consumo de* chicha *de boa qualidade em um cenário Inca regional. Se apresentam vários cenários de interpretação como por exemplo o uso de diferentes matérias primas vegetais para otimizar a fermentação, um uso ritualístico de 'comer com o morto', possível contaminação antrópica ancestral dos recipientes durante vários usos cotidianos e, por último, atividades sociais e rituais associada ao conjunto destes prováveis cenários.*

Canyon region of southernPeru (Bray *et al*., 2005; Reinhard, 2005; Reinhard and Ceruti, 2010); the mummies of Cerro Llullaillaco in northwestern Argentina (Reinhard, 1999, 2005; Ceruti 2003a, b; Reinhard and Ceruti, 2005, 2010), and the Cerro El Plomo child in central Chile (Mostny, 1957). In addition, human sacrifice took place at lower mountain elevations including La Plata Island off the coast of Ecuador, Túcume on the Peruvian north coast, Choquepukio in the Cusco Valley of Peru, and at Puma Punku on Tiwanaku, Bolivia (McEwan and Van de Guchte, 1992; Bray *et al*., 2005; Knudson *et al*., 2006).

In 1976, road construction led to the fortuitous discovery of a rich Incan burial ground in Cerro Esmeralda (905masl) near the modern city of Iquique in northern Chile. Here, two young girls of 9 and 18-20 years of age were found buried in a fetal position; their remains were dated to around 1399-1475 A.D. Over 100 fine offerings were also present, including ceramic vessels (*aríbalos*), anthropomorphic and zoomorphic small metallic figurines, possible silver ornaments, *chuspa* bags, and *Spondylus* shells (Checura, 1977; Silva, 2012; Besom, 2013). This burial was classified as a *Capacocha* by several scholars (Checura, 1977; Ojeda, 2012; Silva, 2012; Besom, 2013) because it has six of the seven previously mentioned archaeological features. The only discrepancy is that the burial was found at a lower elevation than usual. Despite its lower elevation, the burial represents a *Capacocha* and can be considered a special burial, with all the paraphernalia and ritual behavior characteristic of the Inca.

Initially, Checura (1977) indicated that the Cerro Esmeralda girls were strangled, but Silva (2012) noted that there are no external or internal lesions on the necks of the mummies to support this claim. The cause of death in Inca human sacrifice is not always immediately evident. Cobo (1990: 156) wrote, "the children were strangled and buried with gold and silver on the hill of Chuquichanca" near Cusco. And indeed, the inhumation findings from Cerro El Toro (Quevedo and Durán, 1992) and Cerro Aconcagua (Gentile, 1996; Schobinger, 1999) show evidence of trauma; but others may have died of hypothermia assisted by imbibing special drinks, *chicha* for example. In fact, the analyses by Wilson *et al.* (2013) of the Llullaillaco mummies confirm the sacrificed children were given large quantities of alcohol before death. Considering the low altitude of Cerro Esmeralda, it is unlikely the girls died of hypothermia (Checura, 1977; Ojeda, 2012; Silva, 2012), which had been suggested as the method for other high-altitude human sacrifices. This opened the door to investigating the type of drink given to the Iquique maidens.

Taking into account the importance of the *aríbalos* vessels and their limited presence as part of the grave goods in

Incan human sacrifice, we focus on micro-sampling of the Iquique *aríbalos* and analyzing their inner surfaces to shed light on the types of fermented drinks the vessels actually contained. We also considered the vegetable-associated materials found in the grave goods. We show that the Cerro Esmeralda *aríbalos* and bags have evidence of fermentable micro-botanical remains (starch and phytoliths). Finally, we discuss the role of *chicha* in this ritual and the cultural significance of these vegetable materials.

Figure 1. Fragmented *aríbalo*, Cerro Esmeralda, MRI 0010.

Materials and Methods

The uniqueness of the Cerro Esmeralda burial and grave goods encouraged the Iquique city museum staff to keep this finding under limited access to handling and research. Thus, we were given a special permit to briefly analyze the Cerro Esmeralda grave goods stored at Museo Regional de Iquique (MRI). We searched for the two *aríbalos* (Figure 1) described by Checura (1977) and vegetable remains with fermenting potential. Table I shows the five organic samples we collected. One sample was taken by brushing an *aríbalo* orange-reddish sherd without decoration (MRI 0010). Two samples were *conchos* or compacted brown organic residues recovered from the bottom of the vessels: a) *concho* sample (MRI 0102) from the bottom of fragmented *aríbalo* MRI 0010 and b) *concho* sample stored in a museum bag labeled 'sediment from vessel' (MRI 0107). Two samples were taken from vegetal material: a) one from a museum petri dish (MRI 0112) with vegetal residues and b) the other from a *chuspa* bag (MRI 0113) containing residues.

Samples were collected using disposable brushes, scalpel surgical blades, and starch-free gloves. New brushes and blades were used for each sample. All samples were stored in sterile containers and analyzed for starch and phytoliths. We took standard safety precautions to avoid contamination (safety cabinet, starch-free gloves, and sterilized materials) during sample processing.

Starches are polymers of carbohydrates and phytoliths are minerals found in plant tissue, both of which have a specific shape and size depending on the type of plant (Pearsall *et al*., 2003; Babot, 2004; Perry *et al*., 2006; Piperno, 2006). To isolate micro-remains we used the combined technique of starch and phytolith recovery proposed by Horrocks (2005). This procedure consists of separating the remains by density using zinc bromide solutions (1.8-1.9g·ml^{-1} for the recovery of starch and 2.3g·ml^{-1} to recover phytoliths). Four drops from the solution were mounted on slides.

The starch observation was undertaken by mounting the sample with five drops of glycerin and using a microscope with cross-polarized light at a 400× magnification. The phytolith samples were mounted using a Permount™ medium and observed under a bright-field light microscope.

The morphology and size of the starch grains and phytoliths were taken into account to determine the type of plant present by means of comparison with micro-remain catalogs, specialized literature and comparative (normal and fermented) samples of starch grains and phytoliths (Pearsall *et al*., 2003; Babot, 2004; Perry *et al*., 2006; Piperno, 2006; Hart, 2010; Arriaza *et al*., 2015). However, the absence of certain phytolith plants does not necessarily imply the absence of the plant itself because there are certain taxa that do not produce phytoliths or that do produce non-diagnostic phytolith forms (Piperno, 2006). In addition, two samples (*aríbalo* sediment MRI 0102 and vegetal remains MRI 0112) were microscopically examined for macro-remains.

Results

Of the five samples analyzed (Table II), two (MRI 0112 and MRI 0113) were positive for macro-remains but negative for starch grains. The other three samples –the two vessel sediments (*conchos*) from samples MRI 0102 and MRI 0107, and the sherd brushing (on MRI 0010)– were positive for starch grains but negative for macro-remains, not showing any identifiable plant remains (e.g., cuticle or grains). However, there were a few starch grains

TABLE I
SAMPLES ANALYZED FOR STARCH AND PHYTOLITHS FROM CERRO ESMERALDA

Arica Lab Nº (MIO)	Iquique Museum reference number	Type of artifact	Type of sample	Weight (g)
782	MRI 0010 Caja 7	*Aríbalo* sherd	Organic sediment brushed from a ceramic fragment that corresponds to the *aríbalo* bottom.	<0.1
786	MRI 0102 Caja 11	*Aríbalo,* fragmented	Compact organic sediment from the *aríbalo* bottom. The sediment is V-shaped, similar to the *aríbalo* base.	3.3
793	MRI 0107 Caja 11	Vessel	Compact organic sediment associated with vessel content.	8
794	MRI 0112 Caja 11	Bag	Vegetable sample of seeds, leaves, and fruit.	0.8
795	MRI 0113 Caja 11	*Chuspa* bag	Organic sediment associated with *chuspa* bag.	10.9

TABLE II
TYPES OF STARCH GRAIN FOUND AT CERRO ESMERALDA

Iquique Museum reference number	Type of artifact and sample	Cucurbita/ lagenaria	*Phaseolus* sp.	*Zea mays*	Possible *Manihot*	Total
MRI 0010 Caja 7	*Aríbalo* sherd, sediment (brushing)	0	1	1	1	3
MRI 0102 Caja 11	*Aríbalo*, sediment	1	1	2	0	4
MRI 0107 Caja 11	Vessel, sediment	1	0	0	0	1
MRI 0112 Caja 11	Bag, seeds, leaves, and fruit	0	0	0	0	0
MRI 0113 Caja 11	*Chuspa*, sediment	0	0	0	0	0

including *Zea mays* (corn), different types of *Phaseolus* sp. (common beans or beans) and *Cucurbita/Lagenaria* (gourds). We also observed, in the compact organic *aríbalo* sediment sample (MRI 0102), agglomerates of *Phaseolus* sp. starch, which suggested cooking. The other grain types that were found appeared to be non-clustered (normal). The brushing sediment of the *aríbalo* sherd (MRI 0010) showed the presence of ground *Zea mays* starch, *Cucurbita/Lagenaria* (squash/gourd), and possible *Manihot* (Figures 2a-f). None of the starch showed signs of fermentation and none of the samples revealed the presence of *Prosopis* sp. or psychoactive plant residues, which could have been added to the drinks during the mortuary rituals.

Phytolith analysis identified the presence of eight morphotypes coming from seven different taxa: wavy/polylobed (Subf. Bambusoideae), bilobate punctate (Subf. Festucoideae), bilobate (Subf. Panicoideae), polylobate (Subf. Pooideae), rondel (*Zea mays*), acicular (Cyperaceae), and elongated echinated I (graminoids). Furthermore, few sponge spicules and *Epithemia* diatoms were identified (Figures 3a-j). The *aríbalo* compact sediment sample (MRI 0102) presented the highest diversity of morphotypes (N=7). Many of the found morphotypes correspond to taxa belonging to the monocotyledonous group, which include *Zea mays* and the Poaceae family morphotypes: Bambusoideae, Festucoideae, Panicoideae, and Pooideae (Figure 4). Finally, the macro-remains analysis showed that sample MRI 0112 were fern leaves and *Schinus* sp. (seeds and fruits).

Discussion

The presence of starch grains and phytoliths of *Zea mays* in sherd brushing on *aríbalo* (MRI 0010) and *concho* compacted brown organic residues (MRI 0102) recovered from the bottom of a fragmented *aríbalo* suggests these vessels contained corn *chicha*. In other words, the *aribalos* were full of *chicha* when they were interred in the burial. The analysis of the residues showed corn starch but not clear fermented (starch) granules, including the MRI 0107 *concho* sample. Despite the lack of evidence of fermented grain starch (but presence of maize starch), it is still possible that the *aríbalo* contained *chicha*.

This proposition is based on the fact that the *aríbalo* is one of the ceramic vessels associated with imperial drinking paraphernalia of the Late period or Inca Horizon (1430-1532 A.D.), particularly at Cusco city, where *chicha* drinking was highly structured, ritualized, and controlled by the Inca state (Molina, 1943; Lumbreras, 1969; Guamán Poma, 1980; Betanzos, 1996; Dillehay, 2003; Cobo, 1990; Sarmiento de Gamboa, 2007). These dates for the Inca Horizon vary according to the geographic region and the type of samples dated, among other variables (Cornejo, 2014). Despite the large presence of fine and compacted organic ground residues (*conchos*) analyzed, we did not observe fermented starch or the macro-remains of corn residues or other plants. Thus, we propose that this negative finding suggests a careful fermenting process. According to Jennings (2005), ritual *chichas* were thinner than typical household *chichas*. In particular, the production of a higher-quality alcohol drink implies more steps or processes, such as germinating starch (malting), cooking, sieving, and fermenting. Hayashida (2008) states that modern Andean *chicha* brewers obtain high-quality *chicha* by sieving the wort (*caldo*) many times. The sieved material can be ground again and reintroduced to the fermenting solution, increasing the final product's quality. Germinating, cooking, and sieving techniques (e.g., with cloths) will reduce the amount of residual mash and the fermenting (starch) material. These production processes could explain the minimal starch presence in the *concho* residue. The data therefore suggest a careful preparation of *chicha*.

We also need to consider that fermented *chicha* has a short shelf life (days to a couple of weeks, depending on the preparation); it must therefore be consumed shortly after preparation (Hayashida, 2008). As Zori and Urbina (2014: 212) stated, "no fewer than four important Inca routes converge in or near Tarapacá Viejo" and one of them probably

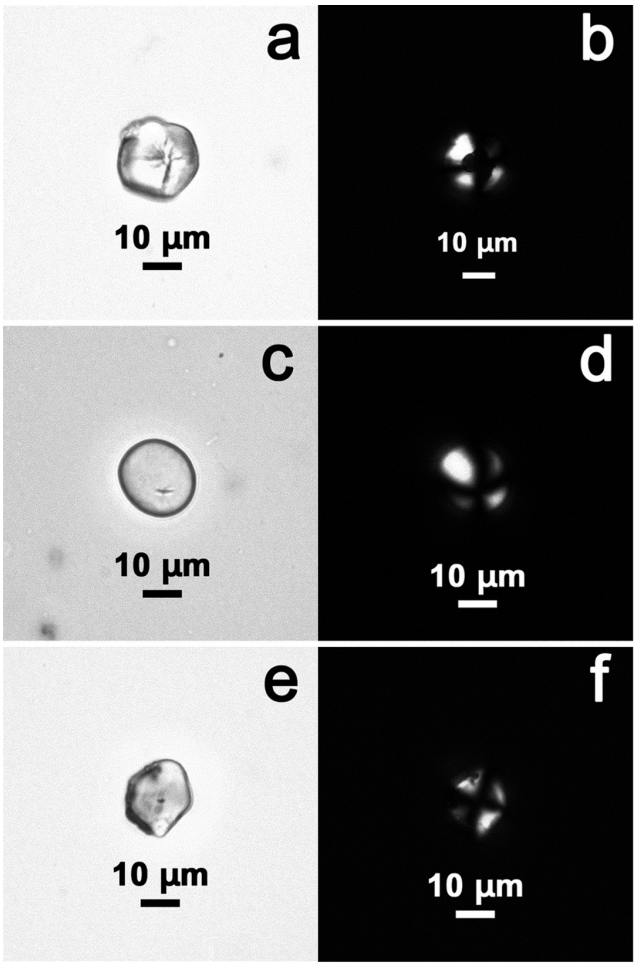

Figure 2. a, b: ground starch grains of *Zea mays*, c, d: starch grains of *Phaseolus* sp., e, f: starch grains of possible *Manihot esculenta*. Left images (a, c, e) were taken under normal brighfield light, right images (b, d, f) were taken under cross-polarized light. All samples from brushing of ceramic sherd (*aríbalo*) of Cerro Esmeralda, MRI 0010.

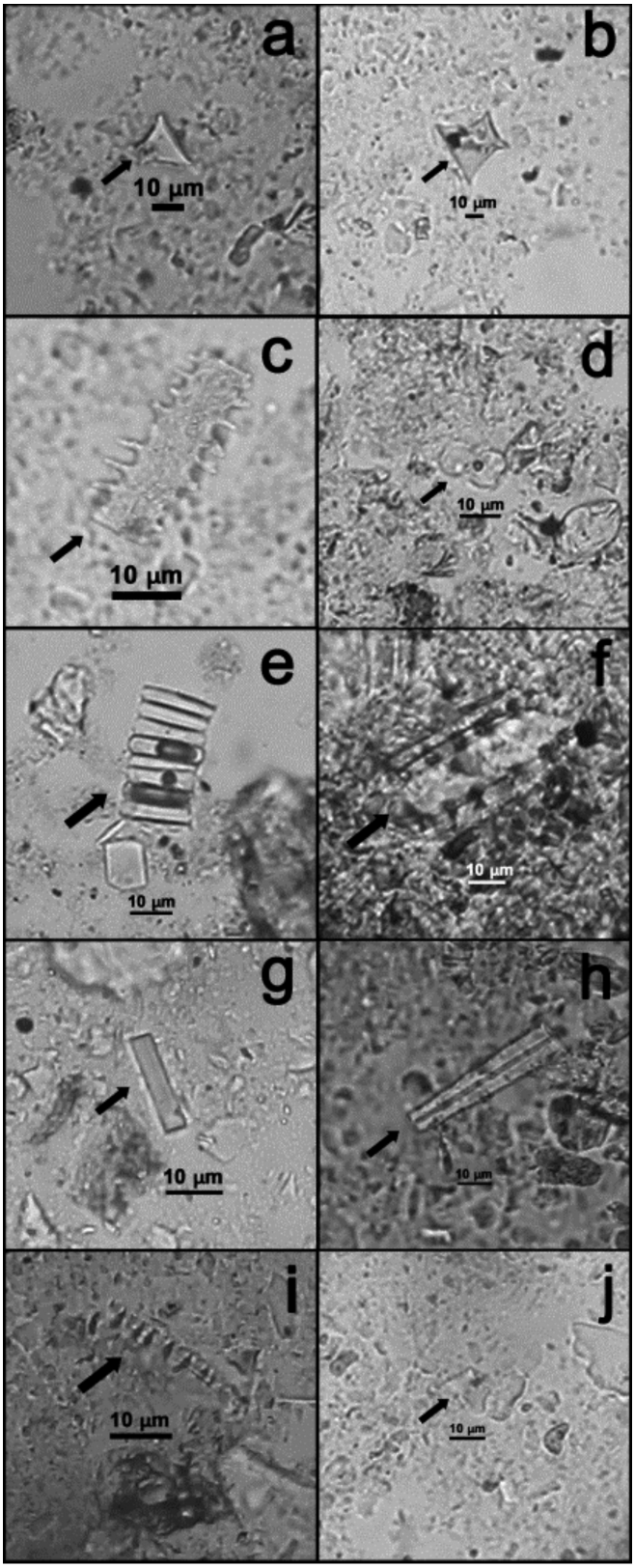

Figure 3. Various types of micro-remains samples found at Cerro Esmeralda. a: Cyperaceae, b: Festucoideae, c: Graminoids, d: Panicoideae phytoliths (samples a-d were taken from *aríbalo* sediment, MRI 0102); e: girdle view of a pennate diatom chain, f: *Epithemia* sp. diatom fragment, girdle view (samples e and f were taken from jar sediment, MRI 0107); g: Dicotyledon phytolith, h: sponge spicule, i: girdle view of *Epithemia* sp. valve, j: *Zea mays* phytolith (samples g-j were taken from *chuspa* bag MRI 0113). All images were taken under brightfield light.

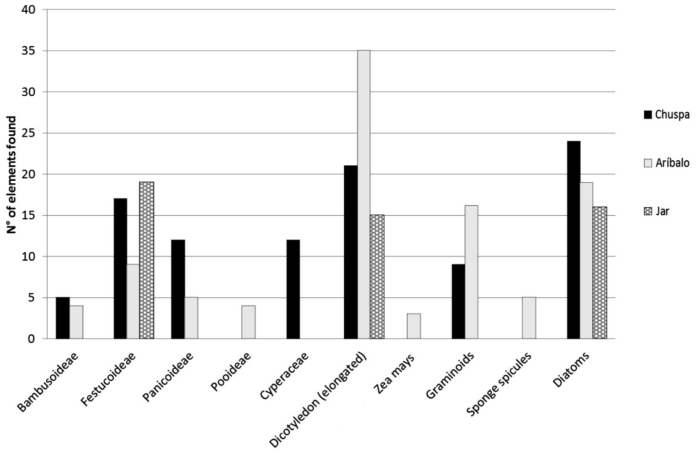

Figure 4. Analysis of morphotypes found in the phytoliths.

connected the valley to the coast, including the Cerro Esmeralda site and the Huantajaya silver mine about 6.5km east of Iquique (see also Berenguer, 2009). Thus, this high quality *chicha* could have been prepared in an important nearby economic center, such as Tarapacá Viejo, about 80km northeast of Iquique. However, the *Epithemia* diatom found in the Cerro Esmeralda vessel residues is present in shallow lakes with high electric conductivity (an indicator of salinity) and coastal rivers in continental aquatic ecosystems, while sponges are general indicators of marine and continental aquatic environments (Figures 3f, I; Tapia, 2008). Ferns and *Schinus* sp. macro-remains (MRI 0112) indicate the presence of important levels of humidity; the first are common in channels and *lomas* and the second in riversides. Thus, with respect to the quality of the water used to make the Cerro Esmeralda *chicha*, the types of phytoliths along with the diatoms indicate both fresh and brackish water, or at least water with high salinity. The quality of water used in the *chicha* preparation correlates well with the environmental conditions of northern Chile's coast. Cerro Esmeralda corresponds to the coastal mountain range that falls steeply over the Pacific Ocean; therefore, the *chicha* of Cerro Esmeralda was probably prepared locally.

The use of plants other than maize is interesting and puzzling. *Phaseolus* is a genus that includes native edible species of the region's coastal valleys such as *Phaseolus lunatus* (lima beans) and *Phaseolus vulgaris* (beans). One possible explanation for the presence of *Phaseolus* starch is that cooked beans were added to aid in the fermentation process. Beans must be eaten cooked; otherwise, they may cause stomachaches and cyanide poisoning (Rodhouse *et al.*, 1990). This requires further investigation as to whether the beans were used to improve fermentation or as nutritional complements during the Inca Horizon. Evidence of remains of both plants has been found in local archaeological funerary contexts, and have an important nutritional and symbolic relationship (Horta, 2013; Arriaza *et al.*, 2015).

Cucurbita/Lagenaria is another edible plant found in the starch *concho* sediments (MRI 0102 and MRI 0107). Its distribution ranges from Mexico to Bolivia (Ugent and Ochoa, 2006). It was also found in Incan *queros* vessels from northern Chile (Arriaza *et al.*, 2015). The presence of *Cucurbita/Lagenaria* in both vessels could be due to *chicha* preparation and serving techniques. Often gourd bowls were used as jug dippers for sipping and serving. Starch grains might detach from the gourds, ending up in the

chicha drink. The possible presence of *Manihot* starch (Figures 2a-f) in the brushing sediment of the *aríbalo* sherd (MRI 0010) is another example of an unexpected plant in this type of vessel. These plants (*Phaseolus* sp., *Cucurbita* and *Manihot*) are not described in colonial documents as a component used to make *chicha* for Inca state libations (Molina, 1943; Guamán Poma, 1980; Cobo, 1990; Betanzos, 1996; Sarmiento de Gamboa, 2007). However, they were found along with maize in *quero* vessels in northern Chile as part of libation paraphernalia (Arriaza *et al*., 2015). The *Zea mays*, *Phaseolus* sp. and *Cucurbita/Lagenaria* sp. were also among the staple foods of ancient Andean agricultural populations in northern Chile (Erices, 1975; Muñoz, 1989, 2004; Pardo and Pizarro, 2005; García and Santoro, 2014; Arriaza *et al*., 2015). Thus, another explanation is that during the Cerro Esmeralda ritual, people drank *chicha* with different types of flour, which today is known as *pihuelo* or *chupilca* (Pardo and Pizarro, 2005). This mixed drink also complements food.

Another possibility is that several plants found in Cerro Esmeralda burials could be related to funeral rituals called *comer con el muerto* (eating with the dead), whereby the assistants or mourners offer food and *chicha* to the inhumations. Finally, in addition to local processes to make *chicha*, the presence of these plants in Cerro Esmeralda burials could be related to local ritual, nutritional, and agricultural behaviors from northern Chile populations. In addition, they could be related to *quero* vessels, which were part of libation paraphernalia, besides the *aríbalos* in northern Chile (Arriaza *et al*., 2015).

The same idea related to local ritual, nutritional, and agricultural behaviors is possibly correlated with the *chuspa* bag (MRI 0113). Checura (1977) stated that a *chuspa* bag recovered from the Cerro Esmeralda *Capacocha* contained coca leaves and ashes (*Llipta*) and that a globular vessel contained *Schinus molle* and *Prosopis* beans. Our macro-analysis supports Checura's (1977) assessments of the presence of seeds and fruit of *Schinus* sp. but no evidence of *Prosopis* beans was found in the analyzed samples. Pardo and Pizarro (2005) debated that *Schinus* sp. and *Prosopis* were also used to make honey and *chicha* during pre-Columbian times in northern Chile. Despite the extensive use of *chicha* made with *S. molle* in the Andes, this fermented beverage is not mentioned in colonial Spanish documents for Inca state libations. Accordingly, the presence of *S. molle* in a *chuspa* bag from Cerro Esmeralda points to a different and potential (local?) raw material to make *chicha*.

The microanalysis sample of the *chuspa* bag revealed six genera of phytoliths, which suggest the presence and use of several different plants for their rituals (Figures 3, 4). Some of the plants could have been edible because elongated dicotyledonous phytoliths come from *Phaseolus*, *Cucurbita*, *Schinus* sp. (seeds to flavor food), and *Acacia* (seeds used as medicinal aid). The Cyperaceae family also has edible parts. In addition, the presence of seven morphotypes in the *aríbalo* compact sediment sample (MRI 0102) corresponds to taxa belonging to the monocotyledonous group, which includes *Zea mays* and the Poaceae family morphotypes: Bambusoideae, Festucoideae, Panicoideae, and Pooideae (Figures 3, 4). Festucoid and Panicoid phytoliths indicate the presence of grasses, while the presence of graminoids is not only an indicator of taxa, but also of specific environments with considerable water availability. Elongated dicotyledonous morphotypes indicate the presence of herbs and shrubs. Thus, the numbers of plants identified in the *chuspa* bag are similar to those found in the *aríbalo*. Supposedly, both objects should have only one type of plant residue (coca leaves and corn beer, respectively), but this was not the case.

It is possible that parts of these results are related to pollution. It is possible that the archaeological materials have been contaminated when they were buried in ancient times, when they were excavated and/or when they were studied. However, our results are consistent across all types of analyses conducted with both micro-and macro botanical residues. The macro-botanical contents of the bag have shown micro-botanical consistent results, while compact *aríbalos* residues (*conchos*) were sampled from inside, where information is encapsulated. Also, other archaeological objects of the Azapa Valley in northern Chile used in libation, such as *queros*, have shown similar results (Arriaza *et al*., 2015). This suggests transverse rituals occurred in funeral behavior, placing local agricultural products as offerings. These products (corn, beans, *molle*, etc.) are found in *chicha* vessels and *chuspa* bags, perhaps as part of *Collasuyu* funeral practices. In brief, all these plants found in Cerro Esmeralda grave goods may have more important local funerary ritual values than the obvious nutritional and fermenting properties.

Final Comments

The presence of the starch grains and phytoliths suggest the preparation of high quality *chicha* (albeit using low-quality local water) in Cerro Esmeralda under the Inca state. We expected that *chicha* vessels would contain only one type of vegetal product (maize) but, contrary to expectations, we found several species of plants in the residues. There are at least four possible scenarios that could explain the existence of various species of plants in the vessels (*aríbalos*) of Cerro Esmeralda. First, the *chicha* was prepared mainly with maize but was complemented with other plants such as *Phaseolus*, *Cucurbita*, and *Manihot* flour (*pihuelo*). Another possibility is that the vessels contain flour of different products as part of the mortuary ritual of feasting with the dead (*comer con el muerto*). The third explanation is that the pot containers (*ollas*) used to prepare the wort (*caldos*) were not exclusively utilized to make *chicha* but were also used for multiple cooking purposes, thus contaminating the operative fermenting chain and the final *chicha* product. This last proposition needs further investigation in the archaeological and ethnographic records. Finally, it is also possible that a combination of these propositions, along with symbolic and ritual behavior, could explain the presence of different types of starch grains. The synergy of these possible scenarios could be the essence of rituals at the Cerro Esmeralda burial.

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