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REPORT

Starch Analyses on Culinary Equipment from Chavin de Huantar

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Abstract

Excavations at the Wacheqsa sector from Chavin de Huantar identified contexts from the Middle Formative (1100–900 BC) and Late Formative (900–550 BC) periods. We present results of starch analysis conducted in culinary equipment (ceramics) retrieved from domestic occupations and a large midden. Microbotanical analysis revealed a variety of plant food resources, such as maize, beans, olluco, and possibly chili peppers.

Resumen

Excavaciones realizadas en el sector de Wacheqsa, en Chavín de Huántar, permitieron identificar contextos del Formativo medio (1200-900 aC) y Formativo tardío (900-550 aC). Presentamos aquí los resultados del análisis de almidones realizado en vasijas de cerámica procedentes de ocupaciones domésticas y de un área de desechos. Los análisis microbotánicos revelaron la presencia de una variedad de recursos alimenticios como maíz, frijol, olluco y posiblemente ají.

Keywords: Chavin; Formative; Andes; microbotanical analyses; starch analyses

Palabras clave: Chavín; Formativo; Andes; análisis microbotánicos; análisis de almidón

Chavin de Huantar is in the north-central Peruvian Highlands at 3,180 m asl at the junction of the Wacheqsa and Mosna Rivers (Figure 1). Its surroundings are part of an active topography, for which continuous energy investment was necessary to maintain the safety of the site and its essential associated arable land (Contreras 2017). Chavin is arguably the best-known center from the Formative period in the Central Andes; its architecture has attracted the attention of several researchers who explored the nature of the site (Burger 1992; Lumbreras 1989; Rick 2005; Tello 1960). This is the first time that starch analyses from this site are introduced to the scientific community.

The Wacheqsa sector is located to the north of the monumental core, enclosed by the Wacheqsa and Mosna Rivers (Figure 2). Intense land use and occupation occurred in this sector during the Middle (1200–900 BC) and Late Formative (900–550 BC) periods. It is located between the monumental core and the domestic settlement that stretched north into the modern town of Chavin, encompassing an area of 1.4 ha.

Chronology

Concentrations of archaeological materials were not distinguishable on the area's surface, because it was entirely covered by a landslide that occurred in 1945. Excavations between 2003 and 2005 yielded two precontact occupations, one related to the Middle Formative and the other to the Late Formative (Mesía-Montenegro 2014; Rick et al. 2010). The sector was occupied between 1100 and 550 BC (Figure 3; Table 1; for more details about the Wacheqsa excavations, see Mesía-Montenegro 2007,

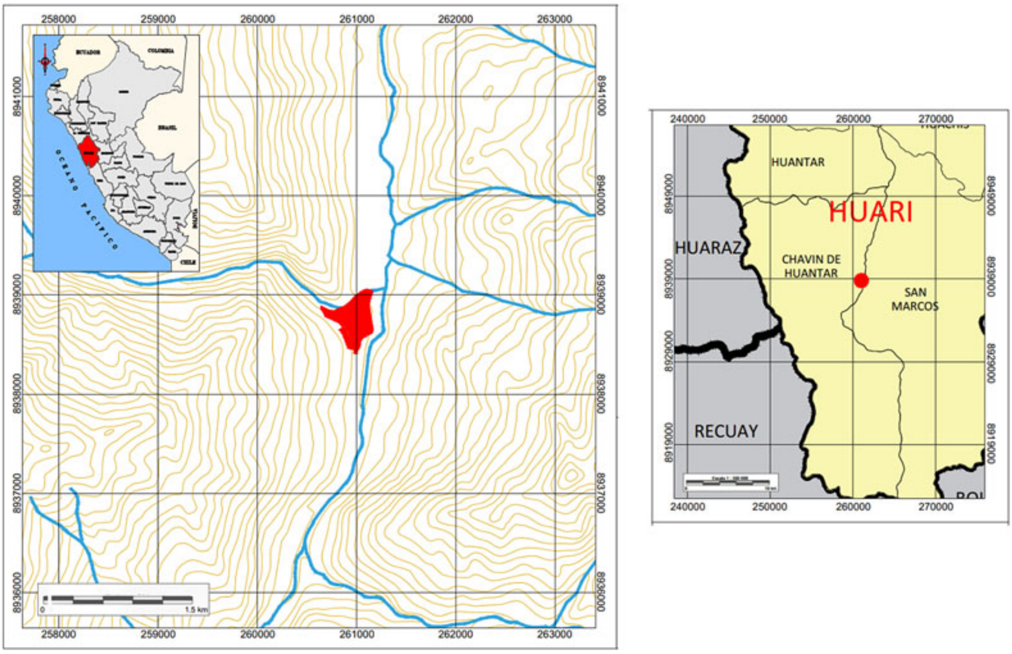

Figure 1. Location of Chavin de Huantar (figure by Christian Mesía-Montenegro).

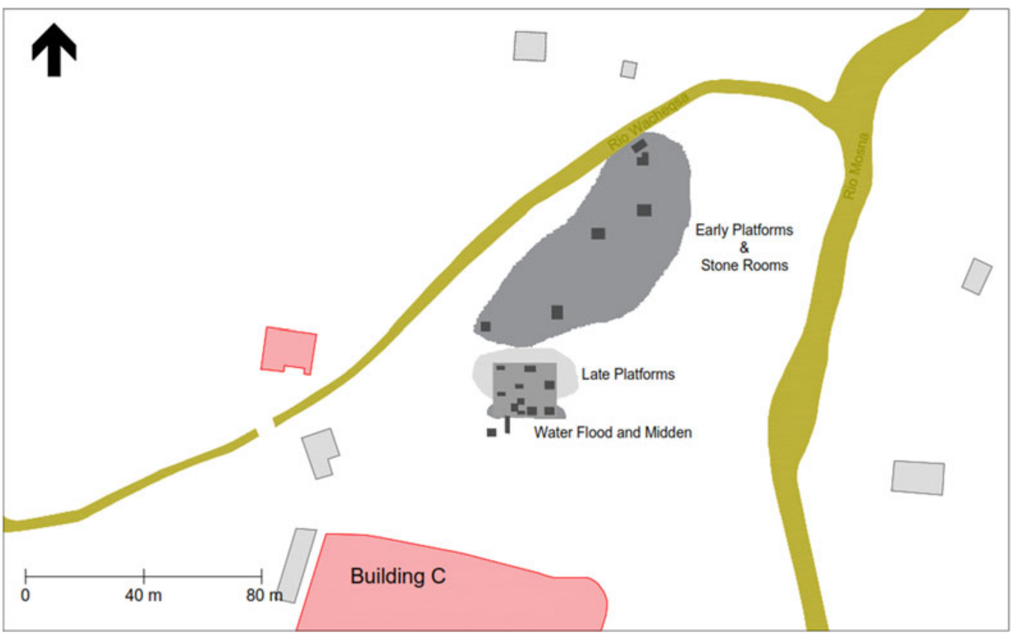

Figure 2. Spatial units at the Wacheqsa sector.

2014, 2022). A new interpretation of the chronology proposed by the Stanford Archaeology Program (SAP) was recently published (Burger 2019), but it ignored all 75 ^{14}C dates published by the SAP (Kembel and Haas 2015; Rick et al. 2010). The inconsistencies of the new interpretation published by Burger will be treated separately in a joint academic contribution.

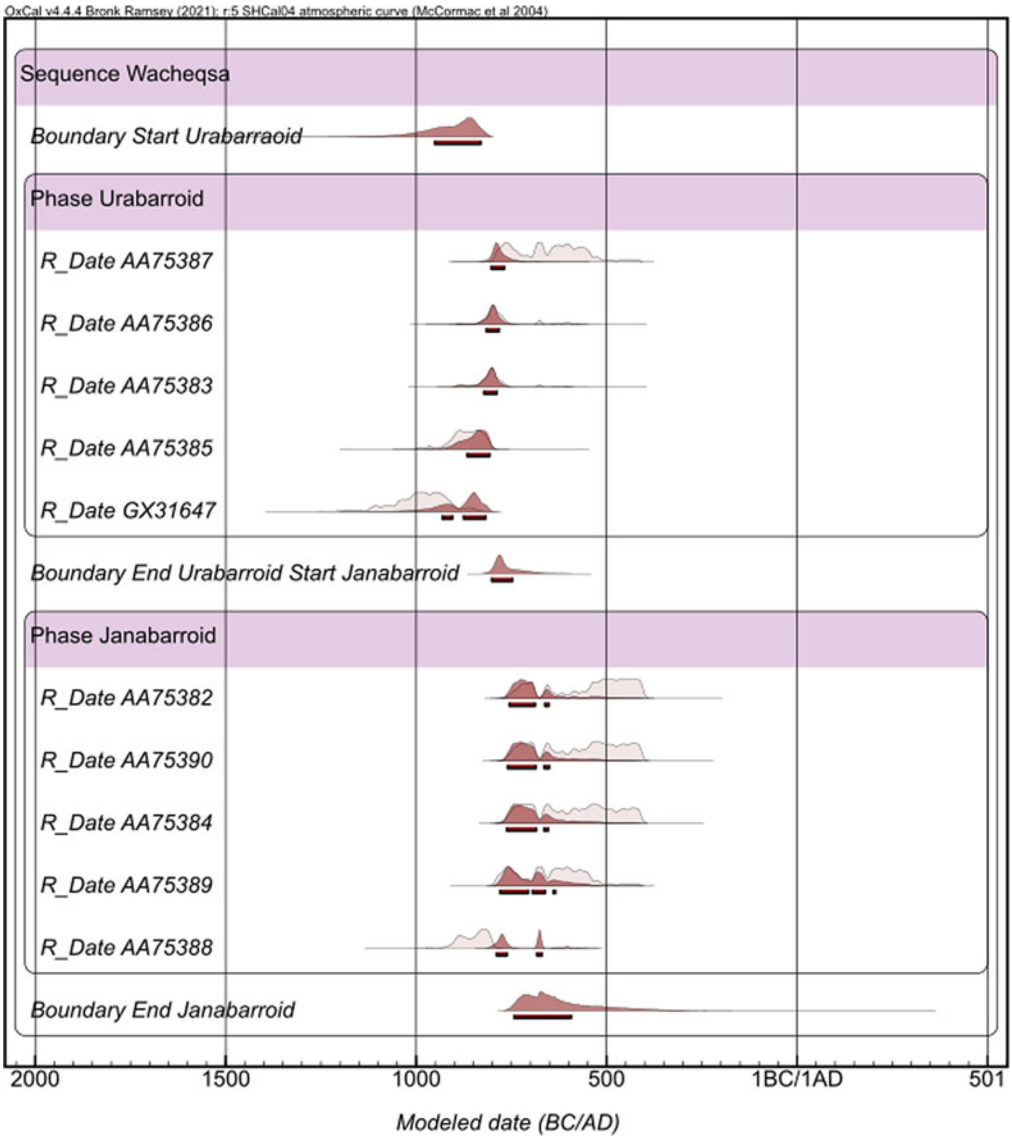

Figure 3. Bayesian model of radiocarbon dates from the Wacheqsa sector (figure by Christian Mesía-Montenegro, made using OxCal v4.4.4; Bronk Ramsey 2021; Reimer et al. 2020).

Middle Formative (1200–950 BC)

This 2003 excavation comprises two spatial units, identified in both the north and south sections, located on top of sterile soil; they represent the earliest occupation. It encompasses the early platforms, which contain evidence of domestic activities (Mesía-Montenegro 2022) and water flood units that have finds indicating water canalization (Mesía-Montenegro 2007). Decorated ceramics are of the types defined as Urabarroid (Rick et al. 2010).

Late Formative (950–550 BC)

This 2005 excavation encompasses three spatial units distributed over the entire area, late platforms, stone rooms, and a midden. The stone room analytical unit represents a settlement in the Wacheqsa sector, where artisans likely lived and worked (Mesía-Montenegro 2022), the midden provides evidence for suprahousehold food and beverage consumption (Mesía-Montenegro 2014), and the

Table 1. Chronological Model Generated by Oxcal.

Sequence Wacheqsa	Dates					Unmodeled (BC/AD)			Modeled (BC/AD)			Analytical Unit
	$\delta^{13}C$	F	± error	^{14}C age BP	± error	from	to	%	from	to	%	
Start Urabarraoid									**−1023**	**−904**	68.26895	
Phase Urabarroid												
R_Date AA75387	−22.2	0.7250	0.0033	2580	36	−806	−761	68.26895	−896	−815	68.26895	Early platforms
R_Date AA75386	−21.8	0.7177	0.0031	2664	35	−892	−797	68.26895	−901	−820	68.26895	Early platforms
R_Date AA75383	−23.7	0.7164	0.0031	2679	35	−896	−803	68.26895	−902	−823	68.26895	Water flood
R_Date AA75385	−23.4	0.7084	0.0031	2769	35	−976	−837	68.26895	−931	−852	68.26895	Early platforms
R_Date GX31647						−1124	−996	68.26895	−992	−899	68.26895	Early platforms
End Urabarroid – Start Janabarroid									**−878**	**−806**	68.26895	
Phase Janabarroid												
R_Date AA75382	−22.5	0.7342	0.0032	2481	35	−757	−543	68.26895	−775	−686	68.26895	Midden
R_Date AA75390	−22.4	0.7325	0.0032	2500	35	−767	−550	68.26895	−780	−668	68.26895	Stone rooms
R_Date AA75384	−22.6	0.7315	0.0032	2512	35	−773	−551	68.26895	−787	−668	68.26895	Midden
R_Date AA75389	−21.8	0.7259	0.0031	2573	34	−805	−600	68.26895	−801	−766	68.26895	Midden
R_Date AA75388	−22.6	0.7110	0.0033	2740	37	−911	−831	68.26895	−847	−803	68.26895	Late platforms
End Janabarroid									**−760**	**−581**	68.26895	

late platforms unit seems to be a buffer area between them (Mesía-Montenegro 2007). Decorated ceramics are of the types defined as Janabarroid (Rick et al. 2010).

Microbotanical Analyses

We analyzed starches retrieved from 63 ceramic sherds recovered from the early platforms ($n = 16$), stone rooms ($n = 15$), and midden ($n = 32$) to explore the diversity of plant foods consumed. Fragments were classified by size: very small, small, medium, and large (Table 2). Neckless jars, bowls, and jars from all three spatial units, as well as bottles in the midden and early platform units, were analyzed.

Our extraction protocol was modified from extant plant microfossil extraction protocols (Fullagar 2006; Fullagar et al. 2006). All working surfaces were cleaned with hydrogen peroxide (9%), and control samples were taken from the working surface, tools, one container, and any other materials used in the extraction process. Contamination by modern starches is a problem in many labs, so we took the utmost care to avoid contaminating the working area. Using powder-free nitrile gloves, we selected and handled fragments and placed them in individual disposable plastic containers with 10 mL distilled water. Objects were agitated with a sonicating toothbrush either directly on the surface for 30 seconds or on the outside of the container for 2–5 minutes to avoid modifying the surface. When the brush did come into contact with the ceramic, it was decontaminated by boiling it for five minutes and then

Table 2. Summary of Vessel Types from Spatial Unit.

	Midden	
Vessel	Sizes	Predominance
Neckless jar	Small, medium, and large	Large
Bowl	Medium	Medium
Jar	Small	Small
Bottle	Small and medium	Small
Cup	Small, medium, and large	Small
Plate	Large	Large
	Stone Rooms	
Vessel	Sizes	Predominance
Neckless jar	Small, medium, and large	Large
Bowl	Medium	Medium
Jar	Medium	Medium
Bottle	Small and medium	Small
Cup	Small	Small
Plate	Small, medium, and large	Large
	Early Platforms	
Vessel	Sizes	Predominance
Neckless jar	Small and large	Small
Bowl	Small and medium	Small
Jar	Very small and small	Very small and small
Bottle	Small	Small
Cup	Absent	Absent
Plate	Small and large	Small and large

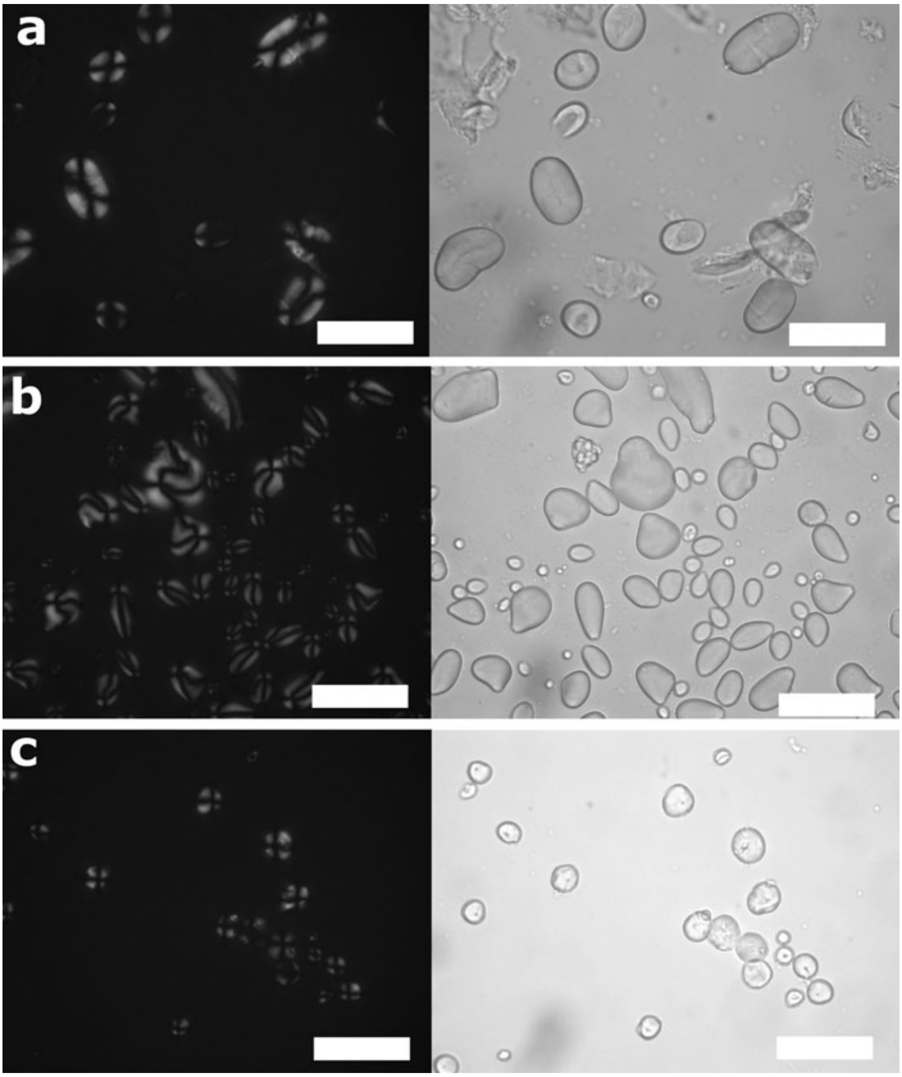

Figure 4. Modern comparative starch granules from plants purchased in Chavin de Huantar in 2015: (a) polarized (*left*) and brightfield (*right*) images of modern *frijol blanco*/white bean (*Phaseolus vulgaris*) starches; (b) polarized (*left*) and brightfield (*right*) images of modern olluco (*Ullucus tuberosus*) starches; (c) polarized (*left*) and brightfield (*right*) images of modern *maíz morado* / purple corn (*Zea mays*) starches. The bar in each image is 50 μm (photos by Sadie Weber).

placing it in hydrogen peroxide (9%) for one minute; the brush was then allowed to dry before the next use. Samples were transferred to clean, labeled centrifuge tubes; after the field extraction, they were mounted on microscope slides with a 1:1 mixture of glycerol and distilled water, covered with a cover slip, and sealed with clear nail polish. Microscopic scanning was carried out with a magnification of 200× under cross-polarized light to enable the rapid identification of starch granules. Ancient starches were compared to either modern reference samples we prepared from local taxa (Figure 4), from a published guide (Pagán-Jiménez 2015), or from previously published work (Perry et al. 2007). Starch morphotypes were defined based on the International Code for Starch Nomenclature (Perry 2011).

Results

Fourteen of 62 ceramic fragments (subsequently referred to as samples) produced preserved microremains, and at least 137 starch granules were recovered (the sample of 62 fragments yielded a cluster of

Table 3. Starches Identified per Spatial Unit and Vessel Type.

Sample ID	Spatial Unit	Vessel Type	*Zea mays*	*Ullucus tuberusus*	*Capsicum* sp.	*Phaseolus* sp.	Indeterminate	Total
CdHW_2	Midden	Neckless jar	2					2
CdHW_11	Midden	Neckless jar	1	1	2			4
CdHW_14	Midden	Neckless jar		1				1
CdHW_18	Midden	Bowl	1					1
CdHW_21	Midden	Bowl	1					1
CdHW_30	Midden	Bottle	7					7
CdHW_40	Early platforms	Bowl					6	6
CdHW_41	Early platforms	Bowl	5					5
CdHW_42	Early platforms	Bowl	8				31	39
CdHW_46	Early platforms	Jar		1				1
CdHW_50	Stone rooms	Neckless jar	1					1
CdHW_52	Stone rooms	Neckless jar	6					6
CdHW_53	Stone rooms	Neckless jar				1	12	13
CdHW_62	Stone rooms	Jar	50					50
Total			**82**	**3**	**2**	**1**	**49**	**137**

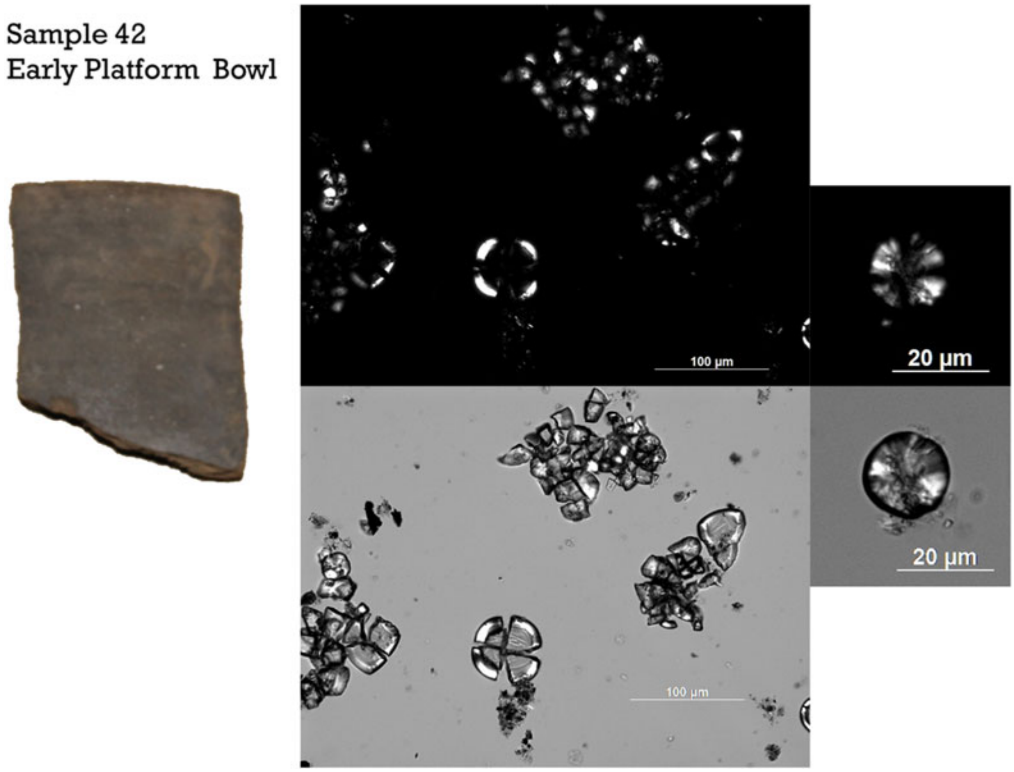

Figure 5. Early platform bowl, showing maize and unclassified starches. The granule in the far right is likely maize, 50 µm (photos by Christian Mesía-Montenegro and Sadie Weber).

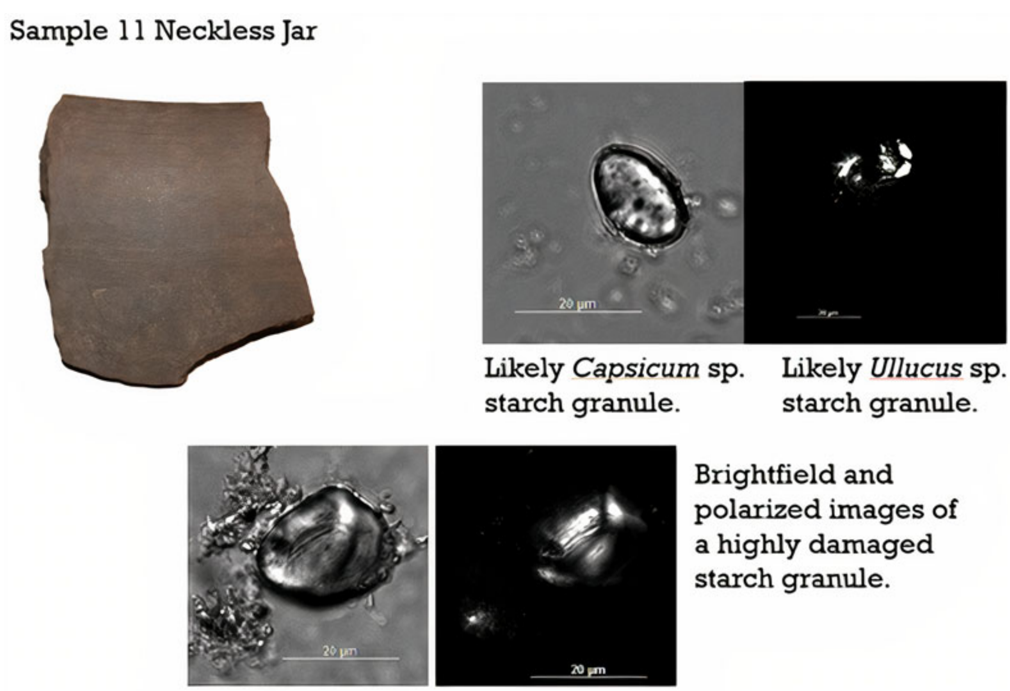

Figure 6. Midden neckless jar, showing *Capsicum* sp. and *Ullucus* sp. starches, 50 µm (photos by Christian Mesía-Montenegro and Sadie Weber).

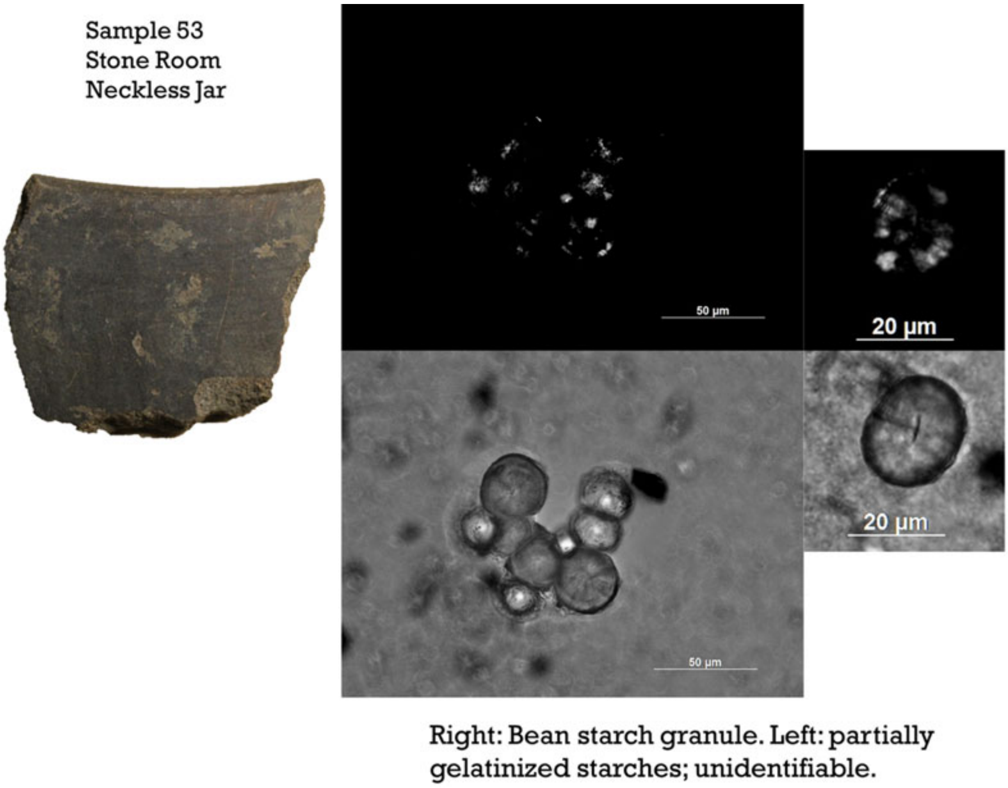

Figure 7. Stone room neckless bean and unidentified starches, 50 µm (photos by C. Mesía-Montenegro and Sadie Weber).

more than 50 *Zea mays* L. starches). Positive identification of starch granules to the species or even genus level can be contentious, so the results we present are conservative without being overly restrictive. The most common identifiable taxon is likely *Zea mays* L., hereafter known as maize. However, the largest category was indeterminate, representing 49 of 137 starch granules. Starches were classified as indeterminate because of damage that modified diagnostic morphologies. We summarize the results of the analysis by area and vessel type in Table 3. Within the early platforms, samples 40, 41, and 42, which are all bowls, and sample 46, a neckless jar, yielded starches. Sample 40 yielded only heavily damaged or modified starches, sample 41 yielded only maize starches, and 42 yielded maize and heavily modified starches (Figure 5). Sample 46, the neckless jar, yielded one singular starch granule that is most likely from olluco (*Ullucus tuberosus* L.), a root vegetable widely distributed in the Peruvian Highlands.

In the midden, samples 2, 11, and 14, which are neckless jars; samples 18 and 21, which are all bowls; and sample 30, a bottle, all yielded starches (Figure 6). Samples 2, 18, 21, and 30 yielded only maize, and sample 14 yielded only olluco. Interestingly, sample 11 yielded olluco, maize, and possibly chili pepper (*Capsicum* sp. L.), although these starches are highly damaged.

Finally, in the stone rooms, samples 50, 52, and 53, all neckless jars, and sample 62, a jar, all yielded starches. Samples 50, 52, and 62 had evidence for only maize, whereas sample 53 yielded bean starches (*Phaseolus* sp. L.) and highly damaged, unclassifiable starches (Figure 7).

Highly damaged, unclassifiable starches were restricted to very few vessels: Samples 40, 42, and 53. Maize was the most identified taxon and occurred in all vessel types. All taxonomically classifiable starch types were found in neckless jars, and the only neckless jar with preserved starch produced olluco. Finally, the only bottle with preserved starch granules, Sample 30, yielded maize granules, all of which demonstrated some damage (Figure 8).

Figure 8. Midden bottle, showing damaged maize starch (photos by Christian Mesía-Montenegro and Sadie Weber).

Macrobotanical analyses from the midden unit identified additional species (Mesía-Montenegro 2014). Maize and beans were recognized in addition to gourds (*Cucurbita* sp. L.) and probably quinoa or Cañiwa (*Chenopodium* sp. L.).

Most starch granules identified were heavily damaged—at times to an extreme that left them identifiable only as starch granules. Previous studies of damage to starch granules have shown that processing of foodstuffs leaves distinct patterns of damage on these granules (Henry et al. 2009; Pearsall 2016). Damage to starches recovered included pitting at the hilum, fissuring, faint extinction crosses, fracture, and gelatinization. Pitting at the hilum is frequently indicative of milling or grinding of the edible part of the plant. Extensive radial fissuring can indicate fermentation of whole seeds, whereas "hollowing out" of the granule indicates that seeds/grains were ground and then fermented (Henry et al. 2009; Vinton et al. 2009). Faint extinction crosses can indicate the partial gelatinization of starches. Gelatinization, which causes granules to change size and morphology, is potentially indicative of heating in the presence of high levels of moisture or, more simply put, boiling. Gelatinization also results in granules' loss of birefringence and extinction crosses under polarized light (Figures 6 and 9). Fractured starches could indicate two processes: freezing or milling. It is also important to note that air dehydration, roasting, and charring also generate changes in starch morphology (Babot 2003).

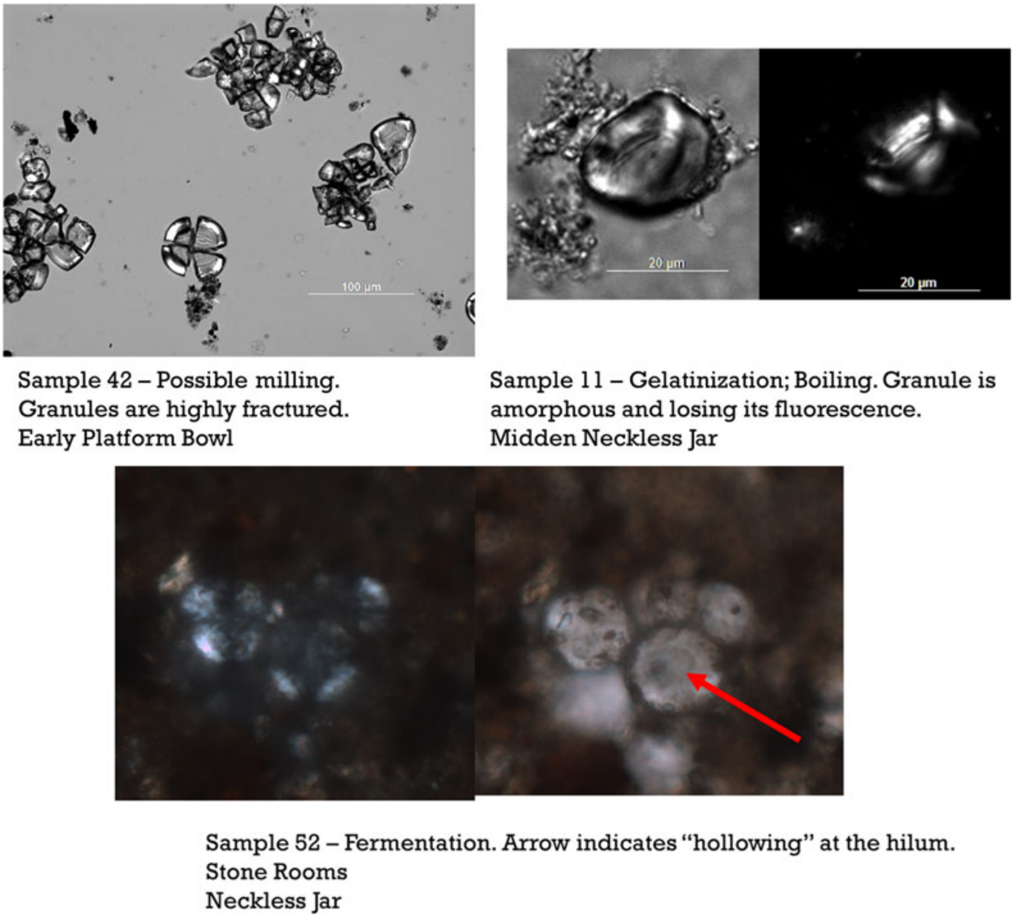

Figure 9. Early platform bowl showing possible milling starches alongside a midden neckless jar with starches showing signs of boiling; a stone room neckless jar with starches showing fermentation, 50 µm (photos by Sadie Weber).

Isotopic data from La Galgada (Washburn et al. 2020) show that maize was not highly consumed at the Tablachaca Valley during the Early Formative period. Evidence from La Banda suggests that its diet was "dominated by tubers and quinoa with the occasional inclusion of maize and beans" (Sayre 2010:172). Earlier isotopic analyses from Chavin similarly indicate that maize was not a staple during the Formative period (Burger and van der Merwe 1990).

Our findings, however, modify previous conceptions about the use of maize at Chavin de Huantar: our starch samples indicate that maize was ubiquitous during the Middle and Late Formative periods. The Wacheqsa sector is within the boundaries of the ceremonial center, whereas La Banda and the modern town of Chavin (where the samples analyzed by Burger and van der Merwe [1990] are from) are outside the ceremonial center. This data may indicate that food consumption patterns within the ceremonial center may differ from those outside the center, but further isotopic analysis from the Wacheqsa sector is needed to shed light on this issue.

Conclusions

We collected starches from 62 vessel fragments found in stratigraphic excavations of the Wacheqsa sector at Chavin de Huantar. Fourteen ceramic fragments yielded at least 88 identifiable starch granules such as maize, olluco, chili, and beans, which were distributed among three spatial units. Maize, which was present in all three units in different forms and frequencies, which is a strong indicator of corn beer (chicha) production and consumption, a beverage widely used in ceremonial contexts through the Andean region (Ikehara et al. 2013; Logan et al. 2012). The midden provided evidence of maize in different stages of preparation (frozen, grinded, fermented, and boiled), which suggests that chicha was probably not the only way in which maize was consumed.

Although these preliminary results need to be supplemented with data from more samples, the documentation presented here aids the ongoing interpretation of food consumption patterns during the Middle and Late Formative periods.

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Data Availability Statement. Excavated materials are curated at the Museo Nacional de Chavín in Peru.

Competing Interests. The authors declare none.

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