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# An Archaeological and Archaeometric Examination of Lead Contamination among Enslaved Populations in Barbados in the Early Colonial Era

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An Archaeological and Archaeometric Examination of Lead Contamination among Enslaved Populations in Barbados in the Early Colonial Era

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by

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## Table of Contents



## Table of Figures

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# Introduction

Historians and anthropologists have investigated lead poisoning among colonial American populations. They argue that lead was an inadvertent component in colonial diets, and that it was introduced by a wide variety of sources, especially through the use of pewter and lead-glazed ceramic tablewares. However, assessing sources of lead contamination within certain populations in a society is complex. Studies have been conducted that offer insight into the nature of lead contamination, such as leaching from lead-glazed ceramics and pewter plates. Yet, these studies offer little insight into that nature of consumer populations and the way their actions, beliefs and behaviors shaped lead contamination and toxicity. In other words, the source of contamination does not necessarily mean that all individuals within that society were subjected to contact from a specific lead source. In addition to the scientific analysis of leaded sources and surviving evidence, the affected society must be examined in historical context in order to discover how interaction, identity, and behavior shaped and contributed to lead contamination.

The limited availability of historical sources can sometimes presents problem when it comes to deconstructing the nature of past societies. This is especially true of enslaved populations because documentary sources are often silent about the lives of the enslaved and they typically offer little evidence for comparison with the wealthy planter class. As a result, historians are limited to inferences made by reading between the lines of historical documents in attempts to shed light on slave life. This can be problematic when it comes to issues of health. Researchers can sometimes lead us to believe that illnesses manifest themselves similarly from group to group. Moreover, afflictions affecting enslaved populations were occasionally misinterpreted or misunderstood by those who wrote about them. In order to work through such dilemmas, a multidisciplinary approach that combines historical research and material analysis proves to be an effective strategy in accounting for underrepresented populations within past societies.

During the 1970's, archaeologists excavated a slave cemetery at Newton plantation in Barbados, where slaves were interred between 1660 and 1820. Although only partially excavated, 104 individuals were recovered and their remains have served as the basis for several key studies pertaining to skeletal comparison and analysis.[1] In *Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence*, Jerome S. Handler et al conducted historical research that specifically addressed the presence of lead in the skeletal remains unearthed at Newton plantation. Following an extensive historical review of materials that contained lead that slaves would have had access to, Handler concluded that lead contaminated rum was the principle source of lead toxicity in that population.[2] He pointed to the use of lead in distillation components and repair, as well as lead material that was present in sugarcane processing, were the most likely sources. In addition, Handler et al suggested that the introduction of heat and increased acidity levels during the distillation process would have exacerbated the lead leaching process.[3]

The purpose of this project is to empirically address Handler et al's assertion that the major cause of lead toxicity within the slave population in Barbados was from the consumption of lead contaminated rum. In order to test Handler et al's conclusions, I have designed an interdisciplinary approach that combines scientific techniques with analysis of historical documents, and archaeological materials. I developed a three-prong approach to tap into the full

[1] Jerome S. Handler, et. al., "Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence," *Social Science History* 10, no. 4 (Winter 1986): 401.
[2] Handler, et. al., 412.
[3] Handler, et. al., 413-415.

potentiality of archaeological evidence and materials characterization studies. The first objective was to explore how lead reacts in rum. According to Handler et al lead would have been present in the final product, but it is important to understand lead's characteristics and the properties of a lead-rum solution. The second objective of this project was to better evaluate a probable point of lead contact. Presumably enslaved peoples consumed rum through glass bottles. In this case, glass cullet was exposed to the lead-rum solution in order to explore how contaminated rum would have reacted with historic glass bottles. The last objective of this study was to determine a protocol that utilized scientific applications in order to test historical glass for traces of lead from potential contact with contaminated rum. Prior to discussing these applications however, it is first important to examine social and symbolic uses of rum in Barbados, and examine the access enslaved peoples on the island had to rum.

# CHAPTER 2

## RUM DRINKING IN EARLY BARBADOS

A fundamental way in which the consumption of alcohol can be studied is through principles of inclusion and exclusion.[4] Social boundaries were symbolically cemented in Barbados through the expressions of what a particular person drank. In order to maintain these boundaries, members of different social classes participated in specific drinking practices, while other groups were excluded from such practices or chose to pursue different drinking behaviors. In other words, the type of alcoholic beverage consumed, the preparation of certain drinks, and the context of drinking performances conveyed messages that distinguished social groups from one another.[5] Furthermore, considering conditions that existed on the plantation landscape such as environmental factors, class, and labor relations, consumption can be analyzed in tandem with certain anxieties faced by Barbadians. When Richard Ligon arrived to Barbados in 1647, he was shocked at the mortality rates on the island and the general sickness of colonists. Although not knowing what the exact causes were, he suspected that rum drinking was a factor. Ligon wrote, "Whether it were brought thither in shipping: (for in long voyages, diseases grow at Sea, and takes away many passengers, and those diseases prove contagious,) or by the distempers of the people of the Iland: who by the ill dyet they keep, and drinking strong waters, bring diseases upon themselves."[6]

European traditions dictated that the consumption of alcohol was both healthful and nutritious. Distilled spirits were incorporated into dietary practices in a way that supplemented very basic and limited supply of food. Additionally, spirits covered a wide spectrum of

[4] Frederick Smith, *The Archaeology of Alcohol and Drinking* (Gainesville: University Press of Florida, 2008), 75.
[5] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 118-119.
[6] Richard Ligon, *A true & exact history of the island of Barbadoes* (London, 1673), 21.

medicinal cures for colds, fevers, pains, reduction of tension, and many other ailments that could be combated by the consumption of a depressant.[7] It was commonly thought that alcoholic beverages aided digestion as well, especially given the kinds of starches and oils that were consumed as a result of meat procurement and preservation.[8] When Ligon accounted for the types of medicines administered to slaves, he spoke of "The inward medicine is taken, when they find any weakness or decay in their spirits and stomacks, and then a dram or two of kill-devill revives and comforts them much."[9] Kill-Devil was the name given to rum prior to its proliferation into Barbadian society. Even though men in the seventeenth century had the propensity to drink heavily, men in the Caribbean tended to drink more due to the year-round heat and humidity. While there were other alternatives to rum in Barbados, such as mobbie or cassava based drinks, rum became the drink of choice given its availability in this sugarcane growing society.[10] Although rum consumption prevailed in all sectors of society in Barbados, it is important to explore the different consumption patterns that helped define and distinguish particular social groups.

Wealthy plantation owners comprised a distinct social group in Barbados. Disposable income or other means to purchase goods at higher prices characterized the ways in which elite planters were able to reinforce their social superiority. This pertained directly to the consumption of alcohol. Wines and brandies imported from France and Spain became a hallmark of the elite.[11] Because these alcoholic beverages had to be imported, the consumption thereof represented a costly signal to other members of society. Richard Ligon stayed with a

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[7] W. J. Rorabaugh, *The Alcoholic Republic: An American Tradition* (Oxford: Oxford University Press, 1979), 25.
[8] Rorabaugh, 117.
[9] Ligon, 51.
[10] Richard Dunn, *Sugar and Slaves: The Rise of the Planter Class in the English West Indies, 1624-1713* (New York: W.W. Norton & Company, 1972), 276.
[11] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 121.

wealthy planter during his time in Barbados, and made note that "We are seldom dry or thirsty, unlesse we overheat our bodyes with extraordinary labour, or drinking strong drinks, as of our English spirits which we carry over, of french Brandy, or the drinke of the Iland, which is made of the skimmings of the Coppers, that boyle the Sugar, which they call kill-Divell."[12] Even though gentility was associated with the consumption of imported alcohols, this practice was not static.

During the early period of colonization in Barbados, especially during the years defined by tobacco cultivation, planters had a difficult time affording such purchases. Furthermore, the importation of brandies and wines often suffered failure and were tainted or lost at sea. Prior to the clearing of land during the initial agricultural phase of the island, "the Wines cannot possibly come good, for the ways are such, as no Carts can passe; and to bring up a But of Sack, or a Hogshead of any other Wine, upon Negres backs, will very hardly be done in a night, so long a time it requires to hand it up and down the Gullies; and if it be carried in the day-time, the Sun will heat and taint it."[13] In order to supplement such a loss, planters consumed rum as well. But as sugar production became profitable and plantation owners started to generate wealth towards the latter part of the seventeenth century, wealthy whites were able to purchase imported alcohol again. Rum was then considered a very coarse drink, only fit for servants or slaves because imported liquors marked a status symbol of wealth and gentlemen-like identity.[14] Moreover, given the increasing number of African slaves, it was likely that wealthy planters would have switched to imported alcohol in order to widen social boundaries.[15] While this practice created solidarity amongst white planters, the cost of imported alcohol excluded enslaved peoples from

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[12] Richard Ligon, *A true & exact history of the island of Barbadoes* (London, 1673), 27.
[13] Ligon, 39.
[14] Richard Dunn, *Sugar and Slaves: The Rise of the Planter Class in the English West Indies, 1624-1713* (New York: W.W. Norton & Company, 1972), 277.
[15] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 122.

this social marker. In addition to imported alcohols however, wealthy planters maintained a way to consume rum that reinforced their social superiority. Instead of drinking kill-devil or freshly distilled rum called *new rum*, aged rum was preferred by those who could afford it. Aged rum was thought to be more refined and was considerably less harsh than *new rum*. Wealthy planters also adapted this superior rum to a specific drinking style.

Rum punch was a mixed drink that was shared by the plantation elite following their reversion back to imported alcohols. It was an elaborate concoction formulated from a variety of ingredients such as exotic Asian spices, as well as different fruits, sugar, and water.[16] The addition of such ingredients, especially those of different spices, differentiated this form of rum consumption by elites because these special ingredients required a greater amount of capital to obtain. While slaves, servants, and poor whites would have consumed rum by itself or used simpler mixtures such as sugar and water, the consumption of rum punch characterized elite status. In addition to this mixture of rum, the ritualistic nature by which it was consumed also marked a symbol of status. This refreshing concoction was made and served out of extravagantly decorated punch bowls, which enhanced the value of these elite drinking events.[17] Furthermore, individual serving vessels were imported pieces often represented by Chinese porcelain.[18] Thomas Tryon's 1684 account in Barbados described a table "set by your Rum-Pots, your Punch-Bowls, your Brandy-Bottles, and the rest of your Intoxicating Enchantments."[19] Wealthy plantation owners as well as other white elites in Barbados fully embraced the social art of drinking, which was part of alcohol-based hospitality.[20] This communal punch bowl was shared by elites who would "invite rich Masters and Dames, and

[16] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 122.
[17] Frederick Smith, *The Archaeology of Alcohol and Drinking* (Gainesville: University Press of Florida, 2008), 75.
[18] Smith, 62.
[19] Thomas Tryon, *Friendly advice to the gentlemen-planters of the East and West Indies* (London, 1684), 96.
[20] Smith, 85.

there they sit Eating and Drinking, (whether they have any Appetites or no) in a formal way, perhaps two or three hours, inticing each other to Gormandize and Guzzle down great Quantities, and variety of rich Food and strong Cordial-Drinks."[21]

Ligon characterized another example of a drinking ritual shared among socially elite whites. He particularly admired the social practice of

> "a Law amongst themselves, that whosoever nam'd the word Roundhead or Cavalier, should give to all those that heard him, a Shot and a Turky, to be eaten at his house that made forfeiture, which sometimes was done purposely, that they might enjoy the company of one another, and sometimes this Shot and this Turky would draw on a dozen dishes more, if company were accordingly; So frank, so loving, and so good natur'd were these Gentlemen one to another."[22]

Although this account was representative of a captivated, idealistic account of gentility in Barbados, it is safe to characterize consumption amongst these elites as very social in nature. While these practices were inclusive, the elaborate and refined nature of these rituals was an attempt by wealthy planters to distinguish themselves from the lower orders of society in Barbados. One could draw parallels to English North American tea consumption in that there was a great deal of specialization amongst actions and materials necessary to properly carry out these activities. In Thomas Tryon's *Friendly advice to the gentlemen-planters of the East and West Indies*, Tryon presented an alleged dialogue between a Barbadian slave and master in which they discussed many of the immoralities involved with slavery. After the slave detailed some of the cruelties related to producing profit for his master, the master responded with "how should we live at the Rate we do? fill our Tables daily with variety of costly Dishes, and swill our selves and numerous Visitants with rich wines, and other strong Liquors: How should we maintain our Grandure, and our Pomp, and raise great Estates of our selves and Children."[23]

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[21] Thomas Tryon, *Friendly advice to the gentlemen-planters of the East and West Indies* (London, 1684), 124.
[22] Richard Ligon, *A true & exact history of the island of Barbadoes* (London, 1673), 57.
[23] Tryon, 208.

Although the consumption of alcohol was perceived as a vital component to maintain their elite standing through sociability, wealthy plantation owners also consumed alcohol in response to anxiety. This anxiety was produced by a number of factors such as resentment from slaves and servants, fear of uprisings, and low returns from crops due to weather or other uncontrollable factors.[24] Nevertheless, the consumption of rum and other alcohols helped create solidarity amongst an elite class through social drinking and interaction, while differentiating themselves from the lower classes.

During his seventeenth century visit to Barbados, Sir Han Sloane remarked “The Air here, not withstanding the heat, is very healthy, I have known Blacks one hundred and twenty years of Age, and one hundred years old is very common amongst Temperate Livers.”[25] Although Sloane provided quite the exoticized account of Barbados, his statement allows us to immediately infer two things about enslaved peoples on the island. First, the reference to “Temperate Livers” implied that not only were slaves consuming alcohol, but self control as a reflection of rate of consumption was an expressed concern amongst whites. Second, Sloane’s account was indicative of the majority of historical data available when trying to piece together consumption patterns amongst slaves in Barbados: white European accounts. European accounts tended to represent slaves as unruly and mischievous drunks. White elites on the island constructed different stereotypes surrounding slaves in order to reinforce social boundaries and order. One of these prevailing stereotypes pertained to constant drunkenness amongst slave populations. Planters feared that slaves found liberation in rum consumption and that drunkenness exacerbated the likeliness of insurrections and threatened social order. But at the

[24] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 141.
[25] Sir Hans Sloane, *A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica* (London, 1707), 9.

same rate, whites used alcohol as a tool of domination and a way to placate their slaves.[26] In order to understand how slaves consumed alcohol in a way that differentiated their status from elite planters, it is first important to consider what kind of rum slaves consumed.

According to Jerome Handler et al, slaves consumed "low-wine" or "new rum" which were known to be strong spirits that had particularly noxious affects.[27] However there seems to be some confusion when referring to both forms of rum. Low-wine was the name given to the initial distillation of rum. It was usually impure and had a considerably low alcoholic content in comparison to further distillations. New rum on the other hand was the product of subsequent distillations ready for consumption. Nevertheless, both forms of rum were associated with a lower standing in the Barbadian social order. In comparison to aged rum, new rum was cheaper to acquire and had lesser value to wealthy planters whose stills produced it. The low-wine that was consumed by slaves was of even lesser quality, and was probably distributed from leftover wash that did not distill over.

Rum was also used to supplement the diets of both slaves and slaveholders. However the way in which planters imposed this dietary supplementation on their slaves helped define the social boundaries between them. While plantation owners enjoyed their imported alcohol or aged rum, they generally allotted every slave family a quart of rum and a quart of molasses for the weekend.[28] New rum or rum from initial distillation batches that was distributed to slaves reflected social inferiority. In addition to this ration of rum that was given for the weekend, slaves were also allowed to participate in markets held on Sundays. Although they required a ticket from their master in order to leave the plantation, slaves were given this day off from

[26] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 126.
[27] Jerome S. Handler, et. al., "Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence," *Social Science History* 10, no. 4 (Winter 1986): 416.
[28] Richard Dunn, *Sugar and Slaves: The Rise of the Planter Class in the English West Indies, 1624-1713* (New York: W.W. Norton & Company, 1972), 278.

labor. But in 1685, ruling elites took measures to shut down the slave markets on Sundays in order to prohibit slaves from trading pots of sugar and molasses.[29] This suggested that in addition to facilitating an uncomfortable solidarity amongst slaves, there was a chance that some of these trade goods were stolen. Moreover, given that rum was a disposable item and of some value amongst slaves, rum could have been obtained at these markets as well. The presence of glass bottles in archaeological records of slave markets, such as Jubilee Gardens in Bridgetown, Barbados, further support this assertion. In 1692, the Barbados Assembly passed "An Act for prohibiting the selling of Rum or other Strong Liquors to any Negro or other Slave."[30] Although this act was most likely in response to a thwarted slave uprising, alcohol was deemed a factor in the expression of agency in opposition to social order imposed by whites.

Consumption patterns amongst the slave population also established a sense of solidarity and community. For the most part, the majority of drinking took place during weekend events as mentioned above, plantation holidays, and ceremonial occasions.[31] Due to the spatial segregation of slave dwellings from the manor house, African slaves were able to maintain aspects of community within their own landscape. At night and on weekends slaves were free to dance and sing, and even constructed musical instruments of their own. More importantly however, slaves retained some aspects of distinctly African ceremonies, which often incorporated the use of alcoholic libations. Given the availability of rum in Barbados, new rum was assimilated into these traditions.[32] Although white planters perceived their slaves in negative and nonsensical ways, slaves exercised a great deal of spiritual respect for alcohol.[33]

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[29] Richard Dunn, *Sugar and Slaves: The Rise of the Planter Class in the English West Indies, 1624-1713* (New York: W.W. Norton & Company, 1972), 242.
[30] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 129.
[31] Smith, 129.
[32] Dunn, 250-251.
[33] Smith, 141.

Traced back to Igbo and Akan traditions, slaves participated in oath drinking in order to strengthen alliances and reaffirm community obligations. In this instance, rum tended to be mixed with other components such as blood or dirt, which reflected shared beliefs and commonality.[34] Even though this tradition often took place prior to uprisings, it emphasized a sense of solidarity in general resistance to plantation life. White plantation owners attempted to distinguish themselves from the enslaved through the provisions of inferior rum; however, slaves experienced a sense of solidarity as a result from the substitution of rum for other traditional spirits such as palm wine.

The social integration of rum played an integral role in defining different groups in Barbadian society. The type of alcohol or rum that was consumed and the ritual practices or patterns of consumption that existed greatly affected social boundaries as well as solidarity within individual groups. Plantation owners attempted to mark their consumption in a gentile manner by paying greater amounts for imported alcohol or aged rum. Although the type of alcohol they consumed adapted in accordance with their wealth, white elites created unique ways to consume available rum. In addition to widening the social boundaries between themselves and the enslaved, the ritualistic style of their consumption created a sense of solidarity as well. Gentlemanly behavior and alcohol-based hospitality defined the social interactions between wealthy plantation owners.

This same identity structure based on consumption patterns can be applied to slaves as well. Given economic and other restrictive factors, slaves were forced to consume lower quality rum. Although this reinforced the social boundaries imposed by white elites, slaves incorporated this rum into consumption patterns based on preexisting traditions. In turn, it created a greater

[34] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 163-164.

sense of solidarity amongst the slave population. Rum consumption was unique because it was dualistic in nature: not only did it help reinforce racial boundaries between slaves and slaveholders, it also served to create solidarity within respective groups. Upon exploring how different orders of Barbadian society exercised distinct drinking practices, it is important to examine the distillation process in order to evaluate the role of rum in colonial health.

# CHAPTER 3

## RUM DISTILLING AND LEAD CONTAMINATION

Rum production was not a standardized process and the process entailed a great deal of experimentation by distillers who were determined to produce a valuable commodity from the waste products of sugar production. Like all alcoholic beverages, rum started off as a mash, or a compound created by various ingredients that facilitated the fermentation process. In the case of Barbadian rum, this mash was known as the *wash*, and was comprised of scum, molasses, dunder, and water. Scum was made up from the impurities of cane juice that accumulated at the top of the heated copper. This waste product was skimmed off during sugar refinement, and was transported via buckets or gutters that flowed to the still house. Molasses was another waste product of sugar production. Sugar was left to dry in conical ceramic vessels, where molasses drained out of a small hole in the bottom. It was then collected and transported to the still house and added to the wash. Dunder was made up from the leftover wash components from previous distillations, with much of its wet matter removed. Water made up the fourth ingredient.[35]

Although the wash was comprised of principle ingredients that produced a fermenting mash, variations occurred due to the availability of waste products during sugar refinement and rule of thumb practices. Distillers attempted to construct compounds that would yield high amounts of alcohol in order to increase profit. However proportions were restricted to the availability of ingredients and changed from wash to wash. For instance, scum was excessively available at the beginning of sugar production, but tapered off towards the end and ceased altogether at the end of sugar refinement. Conversely, molasses was scarce at the beginning of

[35] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 41-45.

sugar refinement but was widely available as sugar continued to dry.[36] Furthermore, the wash was sometimes augmented with "Cane-juice not fit to make Sugar, being eaten with Worms in a bad Soil, or through any other fault".[37] Planters noticed that certain canes were not suited for sugar production due to the high viscosity of their cane juice, but were instead well suited for the wash.[38] Lastly, signature ingredients were often added to distinguish one distiller's rum from the next.[39]

After the wash fermented in cisterns it was added to the still where it was heated. Heat vaporized the alcohol from the wash. Because alcohol has a lower boiling point than other ingredients, the alcohol and lighter substances in the wash (including congeners and essential oils) would evaporate and collect at the top of the still head, and then escape through the still worm. As the vapors traveled through the still worm the alcohol cooled, condensed, and drained into a receiving container. "This Molossus mix'd with Water, as well as scum or juice from bad Canes, is carried into the Distilling-house; where, after Fermentation, when it beings to subside, they in the night time distill it till thrown into the Fire it burns nor; this in the day time is Re-distilled, and from Low-Wines is call'd high Wines or Rum".[40] The initial distillation produced a low-grade alcohol known as low wine, where subsequent distillations removed impurities, increased the taste, and increased the amount of alcohol by volume.[41] Barbadian distillers were also concerned with the volume of alcohol in the final product and often used flammability as an

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[36] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 46.
[37] Sir Hans Sloane, *A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica* (London, 1707), xxx.
[38] Smith, 42.
[39] Smith, 146.
[40] Sloane, lxi.
[41] Smith, 47.

indicator. In 1670, the Barbados Assembly fined planters for producing rum that could not catch fire.[42] Richard Ligon attested to the adverse affects of such a practice:

"We lost an excellent Negre by such an accident, who bringing a Jar of this Spirit, from the Still-house, to the Drink-room, in the night, not knowing the force of the liquor he carried, brought the candle somewhat neerer than he ought, that he might the better see how to put it into the Funnell, which conveyed it into the Butt. But the Spirit being stirr'd by that motion, flew out, and got hold of the flame of the Candle, and so set all on fire, and burnt the poor Negre to death, who was an excellent servant."[43]

The characteristics of the distillation process help shed light on various points of lead contact. Although copper was the main component used to construct boilers, gutters, and stills, lead solder was a common material used to maintain and repair equipment. Handler et al used various historical sources to show that lead was abundantly present, with particular attention paid to still worms that were sometimes comprised entirely of lead or pewter. He then pointed to alcohol's corrosive and acidic properties, as well as the introduction of heat to demonstrate the capability for leaching lead from these components.[44] In the end, Handler et al concluded that these interactions increased the lead toxicity of rum over any other potential source for lead contact, especially pewter tablewares and lead-glazed ceramics. Although Handler et al offered a fairly sound conclusion, a deeper look into total processes raises more questions about the extent of lead toxicity of colonial rum.

The acidity level of ingredients transported through leaded materials would have impacted the amount of lead leached. Cane juice is naturally acidic, and the introduction of heat will cause a decrease in pH levels creating a more acidic product.[45] Taking this into

[42] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 54.
[43] Richard Ligon, *A true & exact history of the island of Barbadoes* (London, 1673), 93.
[44] Jerome S. Handler, et. al., "Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence," *Social Science History* 10, no. 4 (Winter 1986): 413-415.
[45] Ishwar Singh "Post-harvest Quality Deterioration of Cane Juice: Physio-biochemical Indicators" *Sugar Tech* 8, 2&3 (2006), 129.

consideration, it is likely that lead leached from the boilers and gutters from sugar production would have been comparable to that of stills prior to distillation. However, it is likely that the acidic composition of wash ingredients may have increased the potentiality for leaching lead. For instance, the addition of cane juice not suitable for sugar production contained microbial infections that were largely responsible for the deterioration and viscosity of the juice used.[46] Molasses was also continually added to the wash to further stimulate fermentation.[47] Lastly, signature ingredients may have contributed to acidity levels of the wash as well. Although these factors would have increased the amount of lead leached from machinery during the initial stages of rum production, leaching mechanisms are different during the distillation process.

Given the acidity of ingredients and the addition of heat to the wash, it was likely that lead would have been leached from the still to form lead acetate. *However*, as the wash was heated and began to evaporate, lead will not evaporate along with the alcohol causing any leached lead to remain in the wash. The alcohol and other impurities then traveled up through the still and condensed through the still worm. During this phase of distillation, lead was leached from the still worm facilitated by alcohol's acidic and heat properties. This first distillation or low-wine was then collected in a receiver, and subjected to subsequent distillations until desired quality was reached. It is important to note that the amount of lead potentially present in the final product did not increase by accumulation from previous distillations. However, the increase of alcohol purity or content through subsequent distillations may have attributed to higher levels of leached lead from the still worms. Nevertheless, it can be assumed that the final product of potable rum contained lead.

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[46] Ishwar Singh "Post-harvest Quality Deterioration of Cane Juice: Physio-biochemical Indicators" *Sugar Tech* 8, 2&3 (2006), 131.
[47] Frederick Smith, *Caribbean Rum: A Social and Economic History* (Gainesville: University Press of Florida, 2005), 45.

# CHAPTER 4

# MATERIAL CHARACTERIZTION AND ARCHAEOLOGICAL EVIDENCE FOR LEAD CONTAMINATED RUM

In the summer of 2009 I was awarded an Andrew Mellon grant for undergraduate research, offered as part of an initiative program that combined an interdisciplinary approach with the applied science and anthropology departments at The College of William & Mary. Under the direction of Dr. Michael Kelley of the applied science department, I was allotted lab space at Jefferson Lab in Newport News, Virginia in order to conduct experimental lab trials using various forms of lead and alcohol. In addition I learned operational procedures for equipment needed to carry out analyses of these trials, namely a Hitachi 570 scanning electron microscope with elemental analysis owned by The College of William & Mary. In conjunction with the anthropology department, I served as a research assistant for an archaeological field school in Barbados, where I was allowed to collect historical glass samples for analysis. These samples were obtained at The University of the West Indies, Cave Hill, from the Jubilee Gardens and Second Street, Holetown collections. The culmination of these resources enabled me to design a holistic approach in order to examine the role of lead toxicity in colonial Barbadian rum.

*Lead-Rum Observations*

My first objective was to recreate contaminated rum in order to better understand how historical rum would have interacted with lead potentially leached from distillation equipment. Imported Barbadian rum commercially purchased at 40 percent alcohol by volume was selected to represent historical rum. As previously discussed, lead acetate was a potential compound present in the final product, thus was utilized as one of two forms of lead in this experiment. The second form that may have been present in contaminated rum was lead carbonate, which presents itself on the surface of leaded materials. In order to examine different levels of contamination, concentrations of lead-rum were intentionally varied.

Six test tubes were arranged with twenty milliliters of rum distributed to each. Lead acetate was weighed and distributed to the first three test tubes to produce lead-rum concentrations of 5%, 0.5%, and 0.05%. Lead carbonate was distributed in the same way for the following three test tubes. A seventh test tube was filled with twenty milliliters of rum only in order to serve as a control for color comparison. Observations were recorded over a one hour period. Taking into consideration historically variant concentrations of alcohol through multiple distillations, I repeated the above steps but substituted the 40 percent commercially purchased rum with 75.5 percent alcohol by volume rum, and grain alcohol at 95 percent alcohol by volume. The lead-rum was prepared in a sterile environment under a fume hood, and test tubes were sealed in order to prevent contamination and evaporation.

Based upon visual observations, lead acetate in rum formed a suspension with lead particles distributed throughout. In the 0.05% concentration, lead particles almost immediately accumulated at the bottom of the test tube and did not undergo a color change in comparison to the control. When lead acetate was added to achieve the 0.5% concentration, the suspension color changed to a darker brown. Although there was immediate accumulation at the bottom of the test tube, some lead particles remained in suspension throughout. After ten minutes, there were noticeably less particles floating in suspension, and the color changed to a lighter brown. At twenty minutes, all lead acetate particles had visibly settled to the bottom and the color matched that of the control. The 5% concentration of lead acetate and rum reacted similarly to the above concentrations in that after twenty minutes, no particles were visible in suspension. However, the rum maintained a significantly darker brown color than the control.

These observations characterized lead's very low or absent solubility in rum, but the suspension characteristics offered insight into the potentiality of toxic rum consumption. After twenty minutes of lead acetate's contact with rum, lead-rum concentrations of 0.5% or less completely accumulated at the bottom. This suggests that the greater portion of rum would not be toxic until the bottom of the suspension is distributed. When rum was poured from the test tube into a waste container, much of the lead acetate remained accumulated at the bottom of the test tube. This reflects a lesser toxic value of the final rum poured in comparison to its complete concentration and potential toxic value. Extrapolating from this, the greater majority of the rum in contact with lead acetate at a 0.5% concentration or less would not be toxic.

The 5% concentration of lead acetate and rum raised different questions. After twenty minutes it appeared that the greater amount of lead had accumulated at the bottom of the test tube, greatly reducing its toxic value. Between that twenty-minute interval and an hour however, there was no color change, which suggest that super saturation of lead acetate may force particles to remain in suspension. Therefore despite lead's insolubility in rum and the twenty-minute settling period of suspended particles, a 5% concentration of lead-rum may yield a greater toxicity. Even still, it is likely that the lead-rum consumed has a lesser toxic value than expected in comparison to total lead available in rum. In all of these trials, lead acetate interacted similarly with other grades of alcohol.

Lead carbonate reacted similarly to the lead acetate when introduced into rum however the suspension characteristics were slightly different. Instead of turning the rum to a darker brown, lead carbonate created a milky color, which lightened and clouded the original color.

While lead acetate accumulated in a bulk form at the bottom of the test tube, lead carbonate left a lightly coated film over a greater surface area. More importantly, the rum remained a cloudy and lighter color after twenty minutes in all concentrations, despite accumulated amounts of lead at the bottom. Lead carbonate particles were visible throughout and maintained in suspension longer and with more consistency than lead acetate. Varying the grades of alcohol had no effect on these properties.

If lead carbonate was the particular contaminate in colonial rum, consumed rum could be expected to be more toxic than lead acetate contamination. Although time played an important factor in allowing lead particles to settle to the bottom, lead carbonate particles remained in suspension longer and more consistently. Nevertheless, the twenty minute threshold seemed to hold in allowing the greater majority of lead particles to settle, reducing the overall toxicity of potentially consumed rum. Taking all of this into consideration, rum is likely to become more toxic the deeper into the container you are distributing from. Moreover, the surface quality of the container is likely to have a large impact on the consumption of toxic rum. Porous or rough-surfaced containers such as barrels are likely to trap lead particles if contacted with lead-rum, decreasing the potential for toxicity. On the other hand, when the barrel is tapped at the bottom the initial distributions of rum may be the most toxic. The next phase of this study empirically addressed the role of glass bottles in lead-rum consumption.

*Glass Experimentation*

The second objective proved to be a more dynamic study that required the use of scientific instrumentation and analysis. In order to study how lead-rum would have interacted with historic glass bottles, cullet was obtained from the Jamestown Glasshouse. Blown glass was chosen over modern glass in attempts to replicate chemical and surface qualities of early colonial glass. Prior to exposure to lead-rum, glass samples were elementally characterized by an EDS application on the Hitachi 570 scanning electron microscope. Because glass is non-conductive, samples were partially wrapped in aluminum foil while leaving part of the sample exposed. Five tests per sample were recorded of the exposed glass and each reading reflected a surface area of about 288 micrometers.

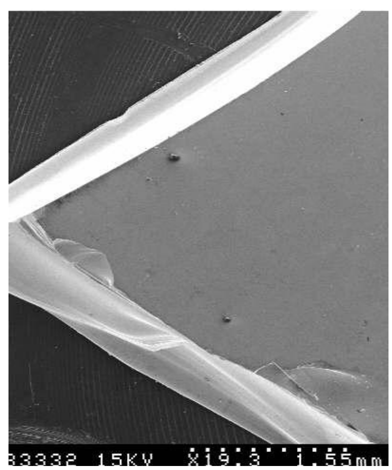
Lead-rum solutions were prepared in plastic containers at concentrations of 10%, 5%, and 2.5% lead acetate per commercially purchased rum. For each solution, twenty milliliters was distributed per three test tubes, and single glass samples were added to each. Test tubes were then sealed to prevent evaporation or contamination. Glass samples were removed from each solution at time intervals of one, three, and six hours. Upon removal of the glass samples from the lead-rum solution, samples were lightly rinsed with de-ionized water to remove adherent particles and left to dry. Each sample was elementally characterized using the same protocol as before.

A second round of trials was performed to reflect varying concentrations of alcohol along with the introduction of lead carbonate. Three test tubes were designated to a lead-rum concentration of 0.5% lead acetate per twenty milliliters of rum solution. The first test tube contained 40% alcohol by volume, the second contained 75.5% alcohol by volume, and the third contained 95% alcohol by volume. The same was applied to three different test tubes with lead carbonate. After settling for twenty minutes, ten milliliters of the decanted solution was poured into separate test tubes, where glass samples were added. After one hour the glass was removed, rinsed with de-ionized water, and set out to dry. Elemental analysis was conducted of each sample.

Glass cullet from the Jamestown Glasshouse was elementally characterized prior to lead-rum contamination in order to create a baseline for comparison. Elemental analysis showed the presence of silicon, sodium, and calcium on all glass surfaces. A point of contention from these analyses however was the inconsistencies of their respective atomic percentages. A sample size of thirty analyses from these different glass samples showed mean atomic percentages of: sodium 23.102 σ1.94, silicon 74.295 σ1.525, and calcium 2.603 σ1.516 (Figure 1). Although the standard deviations for sodium and silicon reflect an acceptable range, calcium appeared to be the most inconsistent. This proved to be concerning because lead was initially expected to exchange with calcium in the glass, much like how lead exchanges with calcium in bones. Nevertheless, the elemental surface characterizations were recorded and compared with analyses conducted after respective exposures to lead-rum.

**Figure 1**

| N=30 | | |
|---|---|---|
| | Mean Atomic % | SD |
| Na | 23.102 | 1.941 |
| Si | 74.295 | 1.525 |
| Ca | 2.603 | 1.516 |
| | | |
| Na/Si | 0.311 | |
| Ca/Si | 0.035 | |




Elemental characterization following lead-rum exposure in the first batch of trials showed fairly erratic results. Lead was not present on the glass surface in the majority of the analyses.

In the very few cases where lead was present, no evidence suggested an exchange occurred on the surface between calcium and lead. In some cases, the atomic percentage of calcium increased where lead was present. To further complicate results, calcium failed to show in some analyses (Figure 2). However, conjectures can be made from these results in tandem with former lead-rum observations.

Although the glass samples were lightly rinsed with de-ionized water following contact with lead-rum, the presence of lead on the surface was likely due to adherent particles. When glass samples were added to their respective lead-rum concentrations, they sank to the bottom of the test tube. Instead of being subjected to evenly dispersed lead in a suspension, samples rested in accumulated lead acetate particles. After further glass characterization, variations in calcium were accounted for with the thickness of glass: greater glass density yielded greater amounts of calcium. The samples used for the first trial were small and thin, which would have accounted for the absence of calcium in some readings.

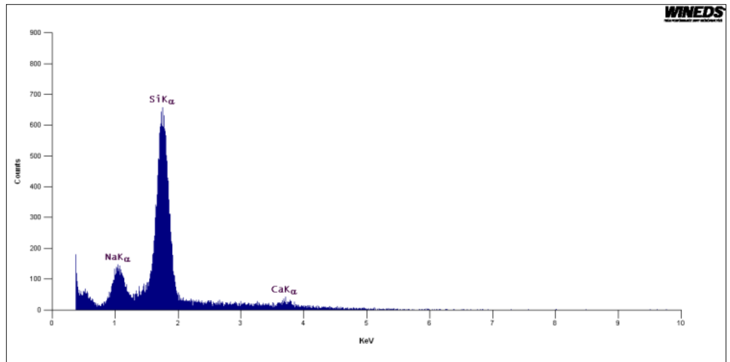
Inferences drawn from visual observations and results from the first set of glass exposure trials defined the methodology for the second round of tests. A lead-rum concentration of 0.5% was chosen for both lead acetate and lead carbonate to reflect desired suspension characteristics. After twenty minutes, total lead acetate was expected to settle to the bottom where as lead carbonate was expected to hold in suspension. The decanted lead-rum from these concentrations was poured into uncontaminated test tubes so that glass samples were subjected to a consistent lead-rum suspension instead of resting in lead accumulation at the bottom. Elemental characterization of glass surfaces showed no presence of lead with the exception of lead acetate in 95% alcohol by volume. But because it showed only in one analysis, it was likely due to adherent particles (Figure 3).

The culmination of these trials helped shed light on the role of glass bottles as they pertain to lead toxicity from rum consumption. Elemental characterization suggested that lead will not exchange with calcium in glass bottles through an alcohol medium. With that being said, prolonged exposure to lead due to the reuse of historic bottles would not have originated from surface leaching from the glass. But a better understanding of lead's properties in rum points to a different hypothesis for prolonged exposure. The majority of lead acetate and lead carbonate accumulates at the bottom of any given container in twenty minutes. Further, surface area characteristics of its container greatly affect how this toxic component is distributed. Historic bottles from the colonial period present in Barbados were made with a distinct kick at the base. It is highly probable that lead particles would accumulate in the narrow space between the kick and the sidewall. After rum was consumed, it is likely that much of the lead accumulation would remain in this narrow space, only to be stirred up into the next fluid that is poured inside. This could lead to small, but prolonged exposure.

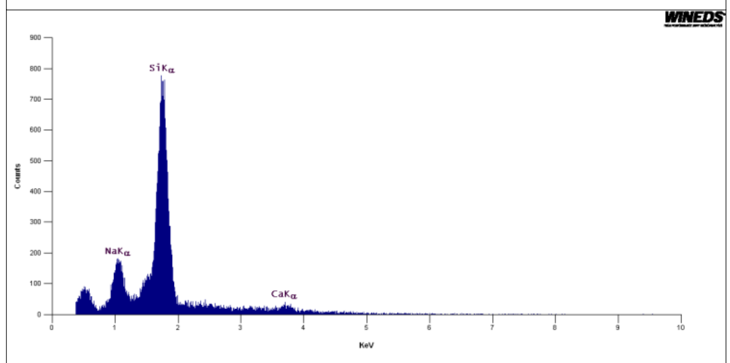
**Figure 2**

Control

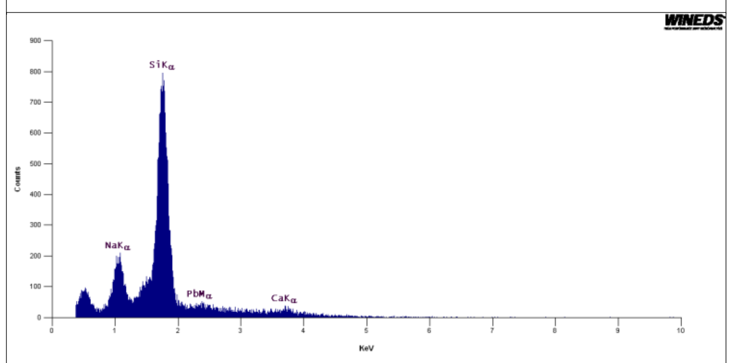
| Element | Atoms% | Weight% |
|---|---|---|
| Na | 21.78 | 18.32 |
| Si | 75.25 | 77.33 |
| Ca | 2.97 | 4.35 |




| Element | Atoms% | Weight% |
|---|---|---|
| Na | 24.95 | 20.02 |
| Si | 72.34 | 70.9 |
| Ca | 1.8 | 2.51 |
| Pb | 0.91 | 6.57 |




| Element | Atoms% | Weight% |
|---|---|---|
| Na | 26.1 | 20.44 |
| Si | 72.45 | 69.33 |
| Pb | 1.45 | 10.23 |




| Element | Atoms% | Weight% |
|---|---|---|
| Na | 23.16 | 19.57 |
| Si | 74.4 | 76.83 |
| Ca | 2.44 | 3.6 |

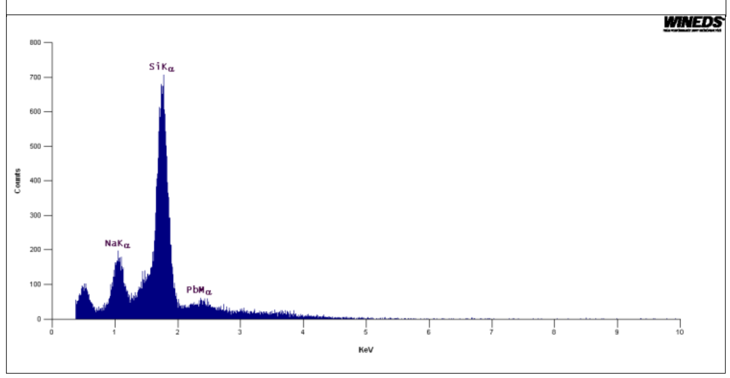
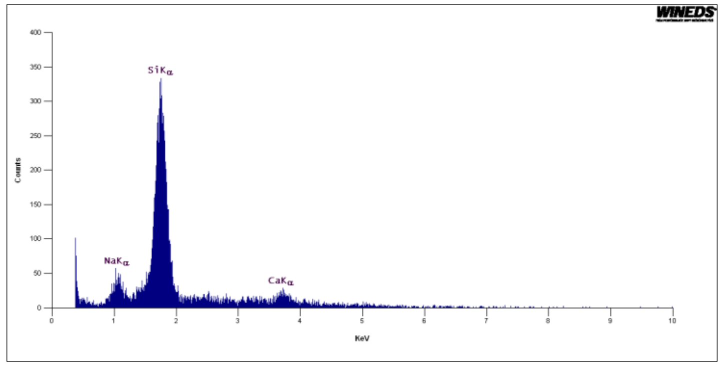
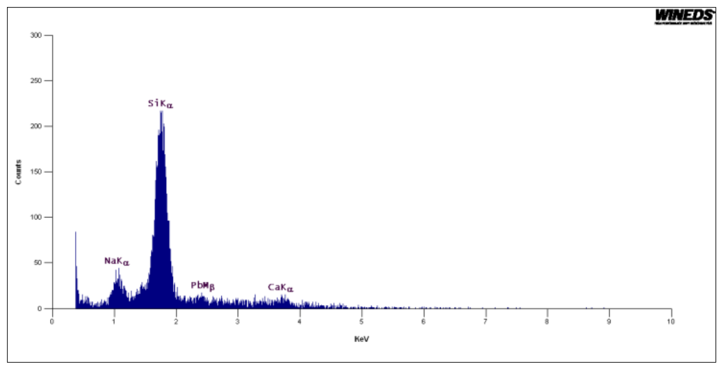


**Figure 3**

| Element | Atoms% | Weight% |
|---|---|---|
| Na | 15.15 | 12.45 |
| Si | 79.41 | 79.74 |
| Ca | 5.45 | 7.8 |




| Element | Atoms% | Weight% |
|---|---|---|
| Na | 18.53 | 13.99 |
| Si | 76.93 | 70.97 |
| Ca | 2.89 | 3.8 |
| Pb | 1.65 | 11.24 |




*Historic Glass Analysis*

Specific sections of historic glass bottles were chosen for elemental analysis considering surface area properties that would affect the distribution and retention of lead particles. As previously discussed, the space between the kick and sidewall presents an ideal space for lead particles to become trapped. However the introduction of curation techniques such as rinsing or brushing could negatively affect the possibility of recovering adherent particles. Moreover, the natural processes that glass undergoes when buried in the ground can alter the glass surface, potentially removing any remaining evidence of lead. Taking such factors into consideration, unwashed bottle base material in excellent condition would be an ideal candidate for elemental analysis.

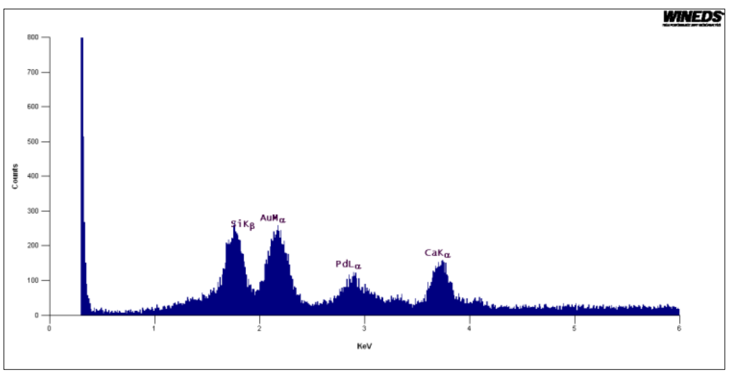
An unwashed glass bottle sample was retrieved from the First Street, Holetown collection, located at The University of the West Indies, Cave Hill. Holetown was the earliest settlement in Barbados, a U-shaped village consisting of two streets named First Street and Second Street.[48] The First Street excavations yielded material reflective of a domestic dwelling, with a sealed context capped in the late 1640's, early 1650's.[49] The sample was selected for testing because it had an intact kick and sidewall, with some of the original dirt still packed in between (Figure 4). The dirt was carefully scraped away to reveal the glass surface, and a diamond saw was used to cut the glass into manageable sample sizes that would fit into the scanning electron microscope. Samples were then coated with gold palladium via a sputter coater due to its non-conductivity.

**Figure 4**

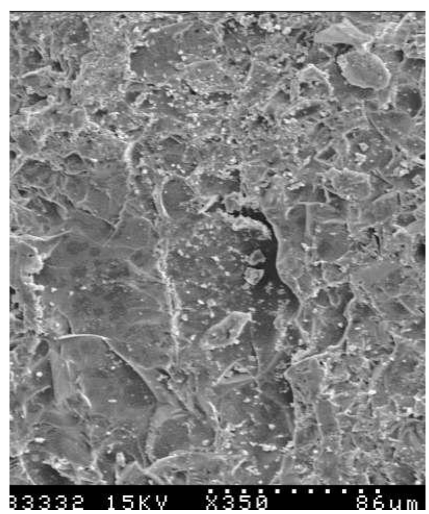

[48] Frederick Smith, Karl Watson, "Urbanity, Sociability, and Commercial Exchange in the Barbados Sugar Trade: A Comparative Colonial Archaeological Perspective on Bridgetown, Barbados in the Seventeenth Century," submission to *The International Journal of Historical Archaeology*, (2009): 4.
[49] Smith and Watson, 5.

Elemental analysis was conducted of the glass surface under the dirt deposit in hopes that any remaining lead would have been trapped between the glass and deposited dirt. Results consistently showed evidence of calcium and silicon in addition to the gold and palladium from the coating (Figure 5). Although lead was absent, further examination of experimental protocol shed light on potential improvements. Palladium peaks occur very close to lead peaks in elemental analysis, so the removal of palladium may be more likely to show lead. In addition, coating the glass sample with a metal may inhibit the microscopes ability to collect certain elements. However this method of coating allows for a detailed image of the sample, which is useful when trying to explore unique surface characteristics that could have potentially retained lead.

**Figure 5**

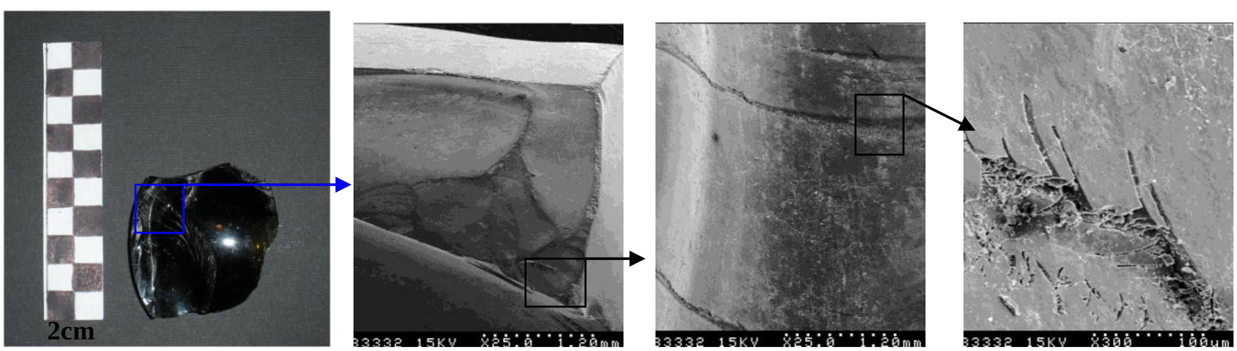



| Element | Atoms% | Weight% |
|---|---|---|
| Si | 36.36 | 14.42 |
| Ca | 33.01 | 18.68 |
| Pd | 14.29 | 21.47 |
| Au | 16.34 | 45.43 |



In order to continue to explore the usefulness of scanning electron microscopy and elemental analysis applied to historic materials, a washed glass bottle sample was selected from the Jubilee Gardens collection, an urban market site in Bridgetown, Barbados. This particular sample was selected due to its unique surface condition. In addition to an intact kick and sidewall the sample appeared to have been trampled, leaving small grooves on the glass surface (Figure 6). Although washed, it was hoped that lead particles may have been pressed into the glass during trauma impact, allowing lead particles to remain on the surface after minimal cleaning. The glass was strategically cut using a diamond saw to create manageable samples that reflected surface areas on both the kick and area between the kick and sidewall. These samples were coated with gold using a sputter coater and then elementally characterized.

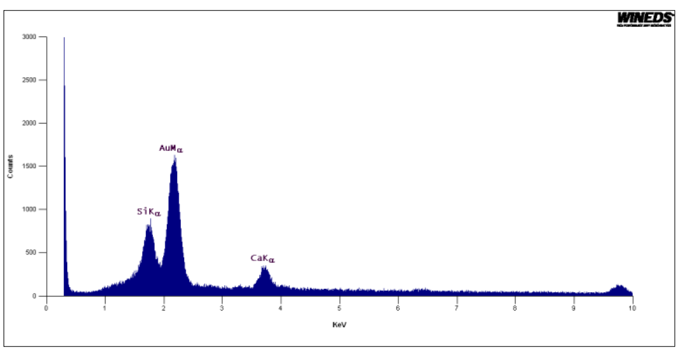
**Figure 6**




A series of ten tests were conducted for one sample reflecting the surface area between the kick and sidewall (Figure 7), and one sample reflecting the bottle kick (Figure 8). These tests were conducted at 600 times magnification in order to sample the area within the grooves left by trauma. Silicon and calcium were present in every test along with gold from the coating, but lead was entirely absent from all samples. An additional set of analyses was also conducted over the cut surface (Figure 9). This reflected an uncontaminated glass surface to potentially serve as a baseline for comparison against glass that had come into contact with its historic contents. Tests of this uncontaminated surface yielded silicon, calcium, and gold. Although comparisons between the contaminated and uncontaminated surfaces ultimately could not reflect historic contents, silicon and calcium readings were intuitively more consistent in the uncontaminated surface.

**Figure 7**

| Element | Atoms% | Weight% |
|---|---|---|
| Si | 36.8 | 10.63 |
| Ca | 23.96 | 9.88 |
| Au | 39.24 | 79.49 |



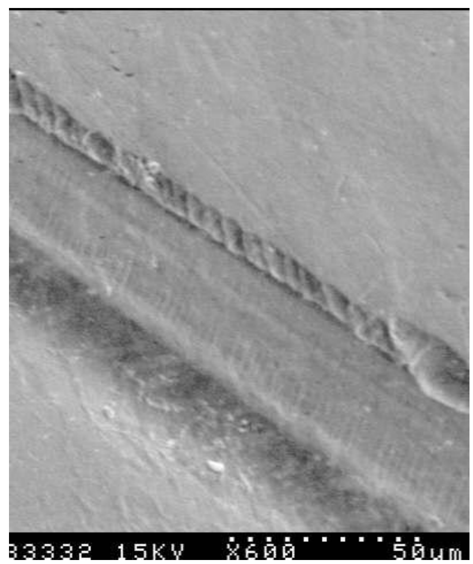
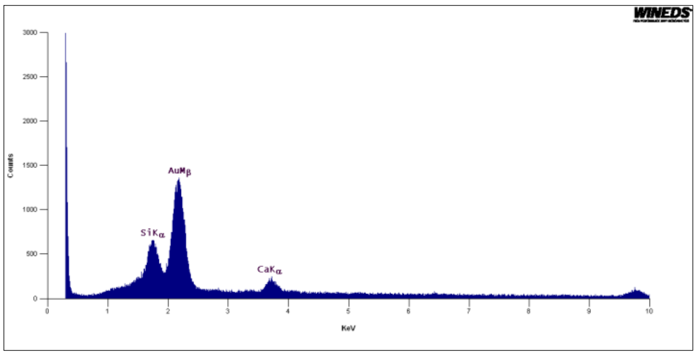



**Figure 8**

| Element | Atoms% | Weight% |
|---|---|---|
| Si | 37.84 | 10.25 |
| Ca | 18.71 | 7.23 |
| Au | 43.45 | 82.52 |



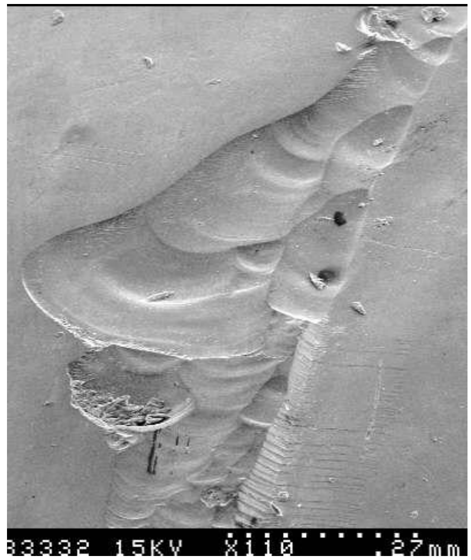
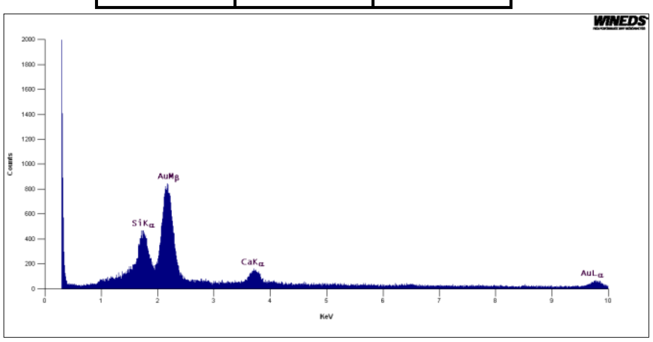




**Figure 9**

| Element | Atoms% | Weight% |
|---|---|---|
| Si | 40.97 | 11.79 |
| Ca | 19.2 | 7.88 |
| Au | 39.83 | 80.33 |




After examining various surface areas on historic bottles, elemental analysis through scanning electron microscopy appeared to be a less effectual way to recover potential evidence of lead. Manipulating historic glass in order to fit procedural parameters for microscopy presented the greatest challenge. Although the Hitachi 570 scanning electron microscope uses a fairly large sample stage able to test large samples, historic bottle bases are very thick. In order to test areas of interest such as the space between the kick and sidewall, the glass has to be cut multiple times. Even still, the thickness of the glass may be too large for analysis and the diamond saw used is not capable of the precision cutting required to cut the glass down any farther. Additionally the kick and sidewall meet to form a sharp angle, where the surface area of the kick or sidewall can obstruct a proper analysis of the space between.

While coating historic glass samples with gold or gold palladium inhibited the ability to potentially find lead, this coating procedure facilitated extraordinarily detailed images of glass surface quality. Exploring outstanding features such as grooves left from trauma or other irregularities may offer insight into surface characteristics that could retain lead from lead-rum. Furthermore, the absence of this coating would make it impossible to run elemental analysis on these features of interest because they would not be visible in an image. However the greatest unknown factor for potentially recovering lead is simply deducting what the bottle was used for. Glass bottles were used and reused for a variety of purposes and may not have contained rum at all. In the end, elemental analysis conducted on historic bottles presented more challenges than results, bringing into question the application of scanning electron microscopy in discovering lead. Yet, the two examples used in this study may have never been used to store lead contaminated rum. Future studies using larger sample sizes of colonial-period glass bottles may in fact provide evidence of lead.

## Conclusion

The culmination of historical research and scientific inquiry has raised important questions about the role of rum consumption in lead toxicity among enslaved Barbadians in the early colonial era. This investigation has allowed for a better understanding of how toxic rum may have affected different populations within Barbados. After examining the use of alcohol in reinforcing social identities along with the methods and performances associated with consumption, it is clear that these historical practices would have potentially affected access to contaminated rum. As such, sweeping generalizations of total population affliction from a single source should be reconsidered.

Based on visual observations of lead content in rum, numerous factors would have affected toxicity levels of the greater portion of rum consumed. If lead acetate was present in the final product, the majority of its toxic content would settle at the bottom of the container after twenty minutes, greatly reducing the possibility for toxic consumption. Toxic values of lead carbonate in rum could be expected to be higher than lead acetate because it holds in suspension with rum for a greater period of time. By applying these principles to patterns of consumption, varying degrees of exposure can potentially be extrapolated.

Consumption of aged rum versus new rum and associated distribution mechanisms would have played a critical role in lead-human contact. Wealthy planters drank rum that had been aged in wooden barrels for a desired length of time. Not only would this allotment of time allow for lead particles to accumulate at the bottom of its container, the porous surface area could trap and remove lead particles from dispensed rum altogether. If rum was dispensed from a tap located towards the bottom of its container however, it could be expected that lead content would be greater than if it was obtained from the top. New rum on the other hand would intuitively be more toxic than aged rum, given that less time is allotted for lead particles to settle. However, this study showed that after twenty minutes the bulk of lead particles would be removed from the majority of consumable rum. To further complicate the matter, super-saturation of lead may cause particles to remain in suspension regardless of time. Ultimately, the extent of lead contamination from the final distillation would need to be known in order to better understand possible toxicity.

Rum's container prior to or at consumption would also affect lead-human contact. This study considered glass bottles as a likely container of rum dispensed from the still or aging barrels. Observations of lead-rum suggest that the bulk quantity of lead would remain in its container because of its insolubility in rum. Moreover, the presence of a narrow space between the kick and sidewall present an ideal surface area for lead to accumulate. Although this study discounted lead's ability to exchange with calcium on the glass surface, adherent particles would remain in the bottle after multiple uses leading to prolonged exposure. During reuse, contents other than rum may have distributed toxic lead particles to certain sectors of the slave population that would not have otherwise been reached.

The transportation of lead-rum via ceramic vessels also demands some future attention. When considering probable origins of lead toxicity amongst enslaved peoples at Newton plantation, Handler et al discounted lead glazed ceramics because archaeological and historical evidence at the time suggested very limited usage.[50] If enslaved peoples transported or consumed lead-rum from unglazed ceramics, the porous earthenware body would trap lead particles and remove them from consumable portions of rum. Conversely, the glazed body of a

[50] Jerome S. Handler, et. al., "Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence," *Social Science History* 10, no. 4 (Winter 1986): 411.

punch bowl increases the likelihood that wealthy planters would come into contact with lead particles present in aged rum.

In order to find evidence of lead-rum in historical glass bottles, the narrow space between the kick and sidewall would prove to be a likely candidate. But because evidence of lead will occur in adherent particles rather than a lead-calcium exchange, the efficacy of elemental characterization will rely heavily on the condition of the glass. Natural processes such as devitrification and soil contamination, or simple curation techniques such as rinsing and brushing could potentially erase lead's presence on the surface. Furthermore, glass bottles were used for a variety of purposes and some may not have contained rum at all. Although microscopic images of surface characteristics may shed light on the possibility for the retention of lead particles from lead-rum, the application of elemental analysis to historic materials proved to be less effective.

Situating modern scientific inquiry within historical contexts can greatly enhance the discussion of human health as it applied to people of the past. This study has shown that understanding lead toxicity is more complicated than accepting its presence in rum due to leaded distillation components. While colonial rum was toxic to a certain degree, further examination of lead-rum raises questions about its contribution to overall lead accumulation in human remains. In the end, questions such as these will only be answered through dynamic research models and interdisciplinary study.

**Bibliography**

Dunn, Richard. *Sugar and Slaves: The Rise of the Planter Class in the English West Indies, 1624-1713,* New York: W.W. Norton & Company, 1972.

Handler, Jerome S., Arthur C. Aufderheide, Robert Corruccini, Elizabeth Brandon & Lorentz Wittmers, Jr. "Lead Contact and Poisoning in Barbados Slaves: Historical, Chemical, and Biological Evidence," *Social Science History* 10, no. 4 (Winter 1986): 399-418.

Ligon, Richard. *A true & exact history of the island of Barbadoes*. London, 1673.

Rorabaugh, W. J. *The Alcoholic Republic: An American Tradition*, Oxford: Oxford University Press, 1979.

Singh, Ishwar, S. Solomon, A. K. Shrivastava, R.K. Singw and J. Singw. "Post-harvest Quality Deterioration of Cane Juice: Physio-biochemical Indicators." *Sugar Tech*8, 2&3 (2006): 128-131.

Sloane, Sir Hans. *A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica.* London, 1707.

.

Smith, Frederick. *The Archaeology of Alcohol and Drinking*, Gainesville: University Press of Florida, 2008.

Smith, Frederick. *Caribbean Rum: A Social and Economic History,* Gainesville: University Press of Florida, 2005.

Smith, Frederick, Karl Watson. "Urbanity, Sociability, and Commercial Exchange in the Barbados Sugar Trade: A Comparative Colonial Archaeological Perspective on Bridgetown, Barbados in the Seventeenth Century." submission to *The International Journal of Historical Archaeology*, (2009): 1-17.

Tryon, Thomas. *Friendly advice to the gentlemen-planters of the East and West*. London, 1684.