# Sugar Production in Medieval Cyprus

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**Title:** Sugar Production in Medieval Cyprus

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# Preface

Writing a MSc thesis during a pandemic was a challenge. The rapid changes which occurred due to Covid-19 could not but leave this research unaffected. The original plan of the thesis was to include the examination of archaeological findings. However, their physical analysis with laboratory work was impossible due to restrictions. Adapting to the new reality, I chose a new subject and conducted a literature-based research. The choice of the topic of the current research was a consequence of a postgraduate course, which explored the Crusader period and emphasized the production, consumption and uses of sugar.

It was particularly pleasing to carry out this research during the quarantine. Being witness of a global scale change and thinking of all the existential demands that came along with Covid-19, I had the chance to evaluate the paths I have followed in my life. Writing this thesis was one of my dreams that came true and I am honestly grateful for this opportunity. Although the anxiety and stress levels were increased, carrying out research in a field that excited me was a fulfilling experience.

In addition, I appreciate the fact that I had the chance to meet excellent researchers. I want to express my deepest gratitude to my supervisors, Professor Vroom and Professor Degryse, who willingly accepted to guide me and give me their valuable advice.

This research could not have been achieved without the help and support of my family. A special thanks to my parents and sisters for their unconditional love, care and encouragement. To my close friends, I want to express my gratitude for their patience and support.

## *Chapter 1*

## *Introduction*

What is common between a glass broken by a stuntman, biofuel and diabetes? Sugar.

Sugar, broadly known as the basic sweetener in western cuisine, is a global commodity with a plethora of uses not only in the modern world, but also in the daily life of our ancestors. Its origin, manufacture, usage and spread are research subjects which have stimulated the interest of many historians, anthropologists and archaeologists, who wished to reveal different facets of human activity, such as agriculture, technology, trade, diet and politics.

This thesis aims at investigating the sugar cane production centers in medieval Cyprus. Sugar is a product which itself leaves no remnants in the archaeological field. Nevertheless, the architectural remains and the material culture that are preserved entail precious information about the technological innovations and inventions occurring during the medieval period. An investigation of the knowledge transfer and the exchange networks is to be conducted by comparing sugar production findings around the Mediterranean. A secondary goal is to contribute to theories related to the work force, power, capitalism and globalization.

The advent of sugar cane has been traced in multiple regions, as various species of saccharum, have been cultivated. *Saccharum barberi* in India, *Saccharum sinense* in China, *Saccharum robustum* and *Saccharum officinarum* in New Guinea, to name but a few (Brumbley, et al. 2009, 2). *Saccharum officinarum* was the most famous that travelled and established in Europe (Smith 2015,9).

Its use and value changed during the centuries. Before the bulk production of refined sugar, sugar was a luxury good. It was used as medicine (Tsugitaka 2014,100), as a redemption of a debt (Aristeidou 1992, 349), as the basic ingredient to make statues (Di Schino 2014,118). However, by the end of the 19$^{th}$ century sugar was no longer a priceless product, but a staple commodity in most households, while recently, in 2015, the World Health Organization published a guideline to

reduce sugar intake in adults and children.[1] To the same tune, in 2020 an article in New York Times sets as a New Year's resolution the reduction of sugar in the diet and gives advice on how to consume less sugar.[2]

The existence of sugar cane was known in the Hellenistic and Roman World (Forbes 1966, 101-102). Its most ancient testimony comes from Theophrastus (371-287 BC), the Greek philosopher and student of Aristotle, who speaks of honey as originated in flowers "*ἀπὸ τῶν ἀνθῶν*", in the air *"ἐκ τοῦ ἀέρος"* or in the canes *"ἐν τοῖς καλάμοις"* (*Frag. 18).* A reference of the same period is mentioned in Strabo, the 1st century BC geographer, who cited the words of Nearchus, the admiral of Alexander the Great. In 325 BC, he described the sugar canes in India as "*reeds yield honey, although there are no bees, and that there is a tree from the fruit of which honey is procured, but that the fruit eaten fresh causes intoxication*." (15.1.20). Dioscorides, in the 1st century CE, refers to a kind of concentrated honey, called "*saccharon, found in reeds in India and Arabia Felix*" (2.104). The contemporaneous Pliny defines *saccharon* as a white substance obtained from India which was gummy, was crackled like salt and was sweet like honey (12.17.32). Finally, Pseudo-Ariannos (1st -3rd centuries CE) in *Periplus maris Erythraei* (=*Geographi Graeci minores*,1, 14), speaks of "*μέλι τὸ καλάμινον, τὸ λεγόμενον σάκχαρι"*, that is "the honey of a reed, called sugar".

Sugar production was launched in both the East and West. During the Ming and Qing period (early 7th century CE)[3] sugar traveled to China and reached Okinawa Japan (Mazumdar 1998, 31). Watson has investigated the period 700-1000, claiming that this was when the Arab agricultural revolution occurred (Watson 1974). Its existence in the west is testified by a papyrus found in Egypt dated in 8th century CE (Müller-Wodarg 1956,47–48). The sugar industry was established in Europe during the Islamic expansion. By the 8th and 9th centuries, sugar cane cultivation flourished in Egypt and Syria, while during the 10th century, it diffused

[1] https://www.who.int/publications-detail/9789241549028 ,accessed on 2 July 2020.

[2] https://www.nytimes.com/2019/12/30/well/eat/sugar-diet-healthy.html, accessed on 2 July 2020.

[3] All the dates mentioned in sugar production are Common Era (CE).

to the Levant and Sicily (Watson 1974, 28). In 14th century, sugar was the most lucrative enterprise throughout the Mediterranean. From the 15th century sugar cultivation and production spread to the Americas. All the above places had moisture and heat, two critical conditions for sugar cane cultivations.

The introduction of the sugar cane industry in Cyprus is a controversial issue (Von Lippmann 1890; Deerr 1949-1950; Galloway 1997; Ouerfelli 2008; Smith 2015). Some researchers stated that the introduction of sugar cane cultivation in the island occurred during the 10th century and until the 12th century there was a limited production (Solomidou-Ieronymidou 1998, 65). However, this assertion has been questioned by Ouerfelli, who suggested that sugar production began on the island during the 13th and 14th century. He justified his opinion by the deficiency of archaeological and written evidence and the short stay of the Arabs on the island (Ouerfelli 2008,105). Indeed, this view is confirmed by the archaeological remains of sugar cane production in Cyprus, which have been dated during the 13th-14th centuries and were connected with the Crusaders, who massively immigrated and established the Kingdom of Cyprus, after the fall of Acre in 1291. Nevertheless, from the written sources we are informed that sugar was known on the island from the 12th century. Abū ʿAbd Allāh Muḥammad al-Idrīsī (1165) mentions that sugar cane was sold in the Cypriot markets (VI, 644). Still, the fact that it has been attested on the island during the 12th century, does not necessarily indicate that sugar was actually cultivated on the island, as it could just well have been an imported product sold in the market.

The last phase of sugar production in Cyprus coincides with the period of the Venetian rule (1489-1570). Political and economic reasons have led to the decline of sugar production. The Ottoman conquest and the competition for cheaper sugar in the West put an end to this flourishing industry. According to Heymak, who visited Cyprus around 1700, sugar plantation *"is wholly laid aside, and the Greeks are entirely ignorant of the process."* (Cobham 1908, 247).

Cyprus was chosen as a case study, due to its special position in Mediterranean commerce. Three archaeological sites namely Kouklia-Stavros, Kolossi and Episkopi-Serayia were chosen for my investigation due to the excellent preservation of both the architectural remnants and their pottery. The natural and

geographical position of the island made it an essential crossing point, not only for the goods coming from east and west, but also for the products that were cultivated on the island. Cyprus was a station for both military and economic purposes. It played a major role in the economic history of the Mediterranean and served as a major trade link between Anatolia and Europe. It was and still is an island where elements from east and west converge and this thesis confirms that Cyprus is once again a melting pot.

### *1.1. Previous Context and Research problems*

Sugar, being the sweet condiment, which has changed the taste of food for centuries, can reveal a lot about the societies of the past and the present. When and why did people start using sugar? What was the technology needed for its production? How often did people consume sugar? These are some of the key-questions that can unveil aspects of human activity.

The long history of large-scale sugar production is dated from the 10$^{th}$ century till the 17$^{th}$ century. Sugar is of great interest, as it provides various research possibilities in a wide range of fields related to agriculture, trade, diet, health, economy and politics. A growing body of literature recognizes the importance of sugar and investigates sugar from the early 20$^{th}$ century.

By the end of 19$^{th}$ century, von Lippmann wrote a pioneering study investigating the history of sugar cane, entitled *Geschichte des Zuckers: seiner Darstellung und Verwendung, seit den ältesten Zeiten bis zum Beginn der RübenzuckerFabrikation (*von Lippmann 1890). Some decades later, Deerr published two volumes exploring the procedure of sugar cane production by region (Deerr 1949-1950). Recently numerous studies, based on written documents of historians, travelers and merchants, have investigated aspects of the production, organization and usage of sugar (Ouerfelli 2008, Tsugitaka 2015, Smith 2015). The anthropological side of sugar and its close correlation with slavery, social power and economy were investigated by Mintz (Mintz 1985). Lately, there has been an increasing interest in the political perspective of sugar, especially considering capitalism (Simpson 2019, Armstrong 2019).

The above studies are mostly focused on the written sources providing information about sugar production. However, as it was proven by Jones (Jones 2016), who examined the archaeological remains of the early sugar production in Jordan, the contribution of archaeology in the exploration of sugar is relevant but still not entirely investigated.

The archaeological evidence of sugar production unveiled in Cyprus is unique. The main excavator, Marie-Louise von Wartburg, of the sugar complex at Kouklia-Stavros, and the excavator, Marina Solomidou-Ieronymidou, at Kolossi and Episkopi-Serayia are the two researchers who carefully examined and published the findings of the three sites (Von Wartburg 1983, 2001, 2014, 2015; Solomidou-Ieronymidou 1998, 2005, 2015a,b). However, they did not study in depth matters of technology, architecture, their origin and their association with the people behind the production. For that reason, this thesis aims at filling this gap and giving new insights into the questions related to architecture, technology and pottery involved in sugar production. Another aspect to be explored is the relationships between the owners and the status of laborers employed. In addition, this research devotes a part to the current popular topics of capitalism and globalization and endeavors to trace their relevance to Cypriot sugar production.

### *1.2. Scope of the Thesis*

The present study focuses on the production of sugar in Cyprus from the 12$^{th}$ to 16$^{th}$ centuries. From the 1980s onwards, the University of Zurich and the Department of Antiquities in Cyprus carried out excavations on the island, which brought to light important findings. More specifically, three sugar production centers, namely Kouklia-Stavros, Kolossi and Episkopi-Serayia were unearthed. These sugar factories belonged to the Lusignan family (1192-1489), the Hospitallers (1210-16$^{th}$ century) and the Cornaro family (1367- 16$^{th}$ century) respectively. Although on the island, there is a plethora of sugar mills, this study is unable to encompass all the sugar production centers, so it investigates only the above, which are the most well-preserved.

The main research question of this thesis is: What can a comparative study of sugar production centers in medieval Cyprus reveal about: the origin and the purpose of the selection of certain technologies used; the ownership and human force involved in sugar production and the socio-economic dynamics at the time?

More specifically, a comparison of the three excavated sites of Kouklia-Stavros, Kolossi and Episkopi-Serayia will be made, in order to identify similarities and differences in the technological and architectural aspects of the sites. A pilot literature research uncovered four specific sub-questions:

a. At Kouklia there are four different machines used for the crushing of the sugar cane, the vertical water mill being one among them. Is this attested in other sugar factories around the Mediterranean? Why was the vertical water mill abandoned on the site?
b. Although in Kouklia and Kolossi animal-driven mills were used in the first stage of the crushing procedure, at Episkopi presses were only employed at this stage. Were presses more efficient? Are they attested in other sugar complexes around the Mediterranean?
c. Why does an extra boiling room exist at Episkopi?
d. What is the origin of the know-how concerning the crushing of the sugar cane? Are there similarities with techniques used in the Levant, where the early stages of sugar production appeared, or were new technologies from the West introduced? If so, which?

In one of the steps of the sugar production process the use of ceramics is involved. An enormous amount of pottery has been found at the three sites at Cyprus. However, only the pottery form Kouklia has been fully investigated and published (von Wartburg 2014). Based on this research a complementary study, combining data from Cyprus and from published sugar production centers around the Mediterranean, aims to highlight aspects of technology and use of these ceramics. A limitation of this thesis is that there was no availability to the primary archaeological sources (due to lockdown and travel restrictions circumstances) therefore the whole investigation is based only on published material. The comparison of pottery in sugar production from Cyprus with pottery originating from sites around the Mediterranean will allow the investigation of the potters' technological choices in the construction of the vessels, as well as the exchange

networks. Therefore, sub-questions that arise are as follows: Was the technology of the pottery-making introduced from the East? Or, did the Crusaders impose a repertoire that was followed by everyone?

Another objective of this thesis is to explore the human force behind Cypriot sugar production. The sugar mills belonged to the elite of the time and an unexplored field is the relationship between them. However, the owners were not the only ones behind the production. An issue that has been discussed throughout the years is the workforce. Many researchers, clearly influenced by the early history of sugar production in the Americas, had proposed that sugar production in medieval times was slavery-based (Galloway 1977; Greenfield 1979; Arbel 2000). Nevertheless, opponents to this view do exist (Tsugitaka 2015; Ouerfelli 2016). The goal here is to provide an overview of the population, the social stratification and the historical aspects of the $12^{th}$-$16^{th}$ centuries, in order to understand the status of the people working in the production line. Was slavery linked to the Cypriot sugar production?

Two of the most popular topics in contemporary archaeological research are capitalism and globalization. Recent research suggests that sugar production is associated with capitalism (Simpson 2019, Armstrong 2019). Could the evidence from Cyprus confirm the relation of sugar and capitalism during this period?

The final purpose of this study is to contribute to the debate regarding the globalization process. Recently, scholars have supported that a number of globalizations have occurred throughout the centuries (Karsten 2012; Jennings 2014; Sachs 2020). This study will pursue the extent to which a globalization process could be linked with sugar production, an unexplored issue in previous studies.

Overall, it is hoped that this thesis will address the above issues and shed light on the technological, social, political and economic aspects of human life in medieval Cyprus.

### *1.3 Methodology*

This thesis draws on a multi-disciplinary approach. Archaeological evidence, written sources in Aristotle University of Thessaloniki and ongoing literature online are examined, in order to explore the sugar production of medieval Cyprus.

The excavation evidence and the post-excavation studies concerning the Kouklia-Stavros, Kolossi and Episkopi-Serayia sites are scrutinized focusing on the understanding of the architecture, the technological aspects and the pottery produced. Moreover, excavation studies across Mediterranean from Near East to Sicily, are used in order to implement a comparative investigation. When necessary, written sources are studied, in order to complement the archaeological evidence to provide further information. The reader should bear in mind that this is a bibliographical research and does not involve any laboratory or in-situ examination of the findings. For this reason, the published data are the primary source of the thesis.

The written sources, including trade documents, travelers' accounts and state archives provide useful information in the examination of the relationship of the owners and the work force used. Lastly, an examination of archaeology in combination with historical fields associated with politics and the economy is carried out. A critical review of studies exploring current scholarly literature dealing with the terms of capitalism and globalization and their possible origins in sugar production is performed.

### *1.4. Structure of the Thesis*

This thesis has been organized in the following way. Chapter Two begins by laying out a brief overview of the historical and the geographical landscape of Cyprus, which is essential for the understanding of the reasons behind the thriving of sugar production of the island. The third chapter presents and critically assesses the data related to the architecture and the technology used in sugar production, in order to trace the technological innovations of this period and their exchange networks. Chapter Four is concerned with the analysis of the ceramics. Firstly, it presents the sugar pottery found at Kouklia. Secondly, a comparative research with

archaeological evidence around the Mediterranean is attempted, aiming to identify the technological choices of potters. Chapter Five deals with the human force behind the sugar production, meaning the owners of the three production complexes and the relationship between them. In addition, to identify whether slavery occurred in sugar production in Cyprus, the local population, the social stratification and historical aspects are analyzed. In Chapter Six, the research focuses on popular themes in archaeological research which are related to capitalism and globalization. The aim is to combine the archaeological data and to investigate whether we can speak about the emergence of a capitalistic system in Cyprus and a secondary goal is to understand whether globalization occurred during this period. Finally, in the last chapter the research questions proposed in all the chapters are discussed, overall results are presented and a conclusion along with considerations for future research is provided.

## *Chapter 2*

## *Cyprus*

The emergence of sugar cane plantations and the reasons behind their appearance in Cyprus are reflected in medieval history and geography of Cyprus. In this distinctive historical place, peoples were in constant communication, exerting and accepting influences, and weaving a multifaceted environment. West and East, whether opposed or coexisting peacefully, had a continual dialectical relationship. Interesting similarities and analogies in the political, economic, historic context, which are simultaneously western and eastern, are highlighted even in Cyprus's recent history.


Figure 1: Bertelli Fernando, "Isola di Cipro", in *Precedaitium clunibus Impone[n]tes Ambitus eius fertur.MMMCDXX. Romae.MDLXII.* Rome, 1562.

### *2.1 The historical landscape*

From the 12th to 16th centuries, four distinct sovereignties ruled the island of Cyprus. Byzantines, Franks, Venetians and Ottomans prevailed, pursuing their own policy and forming the history of the island. In order to acquire a better understanding of the establishment of sugar production, its flourishing and decline, an overview of significant landmarks of the medieval history is necessary.

In 1176, the defeat of the Byzantines by the Seljuks at Myriokefalon marked the end of byzantine operations in the Latin East (Edbury 1991, 3). The Byzantines were no longer able to defend the southernmost of the empire. During the Third Crusade, in 1191, the King of England Richard I the Lionheart (1157-1199) conquered the island ousting the byzantine governor, Isaac Komnenos (1155-1196).

A year later, the island was sold to the Knights Templar, whose policy was unpleasant to the locals and compelled them to resell the island to Richard I (1157-1199). In 1192, Richard I granted the island to the French knight, Guy de Lusignan, who established the Kingdom of Cyprus (Edbury 1991, 9). From that moment, the island would never again be part of the Byzantine empire, while the Kingdom of the Lusignans would survive for almost three centuries, till 1489. During the Lusignan Kingdom, more than fifteen Frankish kings ruled the island.[4]

During the Crusades Cyprus played an important role as it was utilized as a military base and a refueling station. In the course of the siege of Antioch and Jerusalem (1098-1099), Cyprus was a shelter for the Crusaders (Moschonas 2001, 27). Moreover, it served as a Crusaders' meeting point. The German Emperor Frederick II (1194-1250) arrived on the island in 1227, French King Louis IX (1214-1270), in 1248, and King Edward I of England (1239-1307) in 1271 (Edbury 1991, 74-75).

Under the domination of Guy de Lusignan (1192-1194), more than 500 feuds were distributed to soldiers who offered their military service in return (Hill 2010, 40).

[4] This period is described by Greek chroniclers Leontios Makheras and George Boustronios. Leontios Makheras was a Greek-Cypriot diplomat who served in the Lusignan court. His work "Recital Concerning the Sweet Land of Cyprus, entitled Chronicle" (Miller and Sathas 1982) provides a retrospect of the Cypriot history during 1359-1432. George Boustronios was a Hellenized Frank, who continued the chronicle of L. Makheras and described the period 1456-1489 in his work entitled "Διήγησις κρόνικας Κύπρου ἀρχεύγοντα ἀπό τήν ἐχρονίαν αυνς'[1456] Χριστοῦ" (Dawkins 1964).

In addition, a plethora of craftsmen and employees responded to his invitation and moved to the island (Nerantzi- Varmazi 1995,102). Another wave of newcomers reached the island, after the loss of Acre from the Mamluks, in 1291, when Syrian and Latin refugees found shelter in Cyprus (Nicolaou-Konnari 20015,15).

From the 13th century, Cyprus was transformed into one of the most important trading centers of the Eastern Mediterranean. As the Syrian and Palestine trade declined under the pressure of Muslim conquests, the commercial significance of the Cypriot ports was strengthened. During the 14th century, a great commercial development was attested in the island. Merchants, and pilgrims were stationing in Nicosia and Famagusta, which were evolving into large urban and commercial centers with intense economic activity. Agricultural products, wheat, barley, beans, oats, sesame, olives, sugar and wine among them were produced (Coureas 2013,218), while the textile industry and glazed ceramics were all flourishing on the island (Jacoby 2014; Papanikola-Bakirtzis 1994).

The Lusignans, during their domination, were bounded in marriages with royal families from the East and West, a practice which reflected the political and ideological course of the kingdom. Marriages with the royal family of the Kingdom of Jerusalem and the royal families of France and Aragon indicated the Lusignans' close ties both to East and West. One of the most significant marriages was that of King James II (1473-1474) and Catherine Cornaro (1454-1510), the daughter of one of the oldest Venetian families. Catherine Cornaro was the last queen of Cyprus and in 1489, she ceded the island to the Venetians and Cyprus became part of La Serenissima (Hill 2010, 765).

From 1489 till 1571 Cyprus was under Venetian control. The relationship between Venetians and Cyprus is well-known from the 11th century. Already in 1082, Alexios Komnenos (1056-1118) granted privileges to the Venetians to use Cyprus freely (Lock 2013,140). It has been proposed that during the Venetian sovereignty, a colonial relationship had been created, a relationship-omen for the cultivation in the Americas (Galloway 1977,190). Indeed, Cyprus could be considered as a colony, given the definition of colony [5] as "*a country or area controlled politically by a more powerful and often distant country*". However, we should not confuse

[5] https://dictionary.cambridge.org/dictionary/english/colony

the sugar production of the Americas with the one of Cyprus, as they have many differences, concerning the technology and the labor used.

Venice's central goal was to ensure an uninterrupted movement and supply of Venetian ships in the Eastern Mediterranean. But Cyprus was not only a transit point in Mediterranean commerce. Along with the commerce activities, the agricultural activities established in Cyprus transformed the island in a very lucrative center. Agricultural products, such as wheat, sugar, cotton, barley, wine, olive oil (Coureas 2013,218) were exported from the ports of Famagusta, Larnaca and Limassol. Marino Sanudo, a Venetian geographer in 14th century maintains that *"such a huge quantity of sugar was produced in Cyprus, that was sufficient for the whole Christian world*." [6]

In 1571, the fall of Famagusta indicates the beginning of the Ottoman occupation of Cyprus. During this period commodities such as grain, cotton and sugar among them, were still exported. However, decline came soon as the colonial holdings in West Indies started bringing cheaper colonial alternatives.

From the so far overview of the historical landscape of Cyprus, it is evident that Cyprus was a place of political and economic interest. As the Arab geographer Muqaddasi successfully noted "*The island is in the power of whichever nation is overlord in these seas"* (Cobham 1908,5). During all these centuries sugar production followed the historical events. By the end of the 12th century, when the Franks occupied the island a rapid development in trade commences, while in 13th century numerous Italian merchants moved to the island. During this period the sugar production was established in Cyprus. In the 14th and 15th centuries, under Venetian control, the island was transformed into an active international center. Sugar production followed the prosperity of this period. Finally, the Ottoman occupation and the discovery of the New world (1570-1600), corresponding to exhausting raids and to a new competitive market respectively, marked the gradual decline of Cypriot sugar production (Galloway 1977, 193).

[6] "*cum in Cypro tanta quantitas zuchari nascatur, quod Christiani poterunt competenter furniri"* (Sanudo 1972, 24).

### *2.2 The geographical landscape*

Cyprus is situated in the eastern Mediterranean basin at the cross-roads of Europe, Asia and Africa. It is a primarily mountainous territory (Fig.1). The Troodos mountain range dominates the southwest side of the island, while the Pentadactylos mountain range occupies the north of the island. Between the two mountains the plain of Mesaoria lies, which is crossed by the two biggest rivers of the island, Pedieos and Yialias.

Due to the prevalent westerly winds, the main sea routes from the Aegean to the Levant passed through the island, which is often mentioned in written sources as a refueling station (Murray 1995,38-43). During the centuries, the island was used in turn as a trade and military station by Assyrians, Phoenicians, Greeks, Romans and Arabs. This is proved by a plethora of shipwrecks found around the island (Demesticha 2019).

Agriculture was the backbone of the Cypriot economy. The mild climate boosted agriculture and the inhabitants developed commercial activities, which established the island not just as an intermediate station, but as a destination for the ships. Agricultural products, such as cereals, wheat, wine, olive oil, cotton, spices, salt were produced and exported throughout the Mediterranean. Ludolf von Suchen in 1350 described Cyprus as *"an island most noble and fertile, most famous and rich, surpassing all the islands of the sea, and teeming with all good things . . . It is productive beyond all other lands."* (Cobham 1908, 18).

Among the products produced sugar was prominent. All the requirements needed for sugar cane cultivation and sugar production were available in the island. The warm and moist climate, in conjunction with the sea climate, were indispensable for the growth of sugar cane (Deer 1911,18) hence Cyprus was an ideal place for sugar cane cultivation. Two of the most necessary requirements was the water and ample fuels. The forests of Troodos were a rich source of wood, which was an essential fuel for the boiling stage of sugar production.

Water scarcity in Cyprus has been a long-standing problem on the island, yet water has been a major requirement for sugar cane. The annual rainfall was low, and the multi-month drought created a dry climate. However, in the Troodos mountain range, the abundant rainfall creates a concentration of large amounts of

groundwater at various altitudes throughout the outcrops of the Pentadactylos mountain range. There, the slope of the ground created the appropriate altitude difference that the water mills needed to produce energy (Rizopoulou-Igoumenidou 2006, 87). However, the abundance of water needed for cultivations was not always sufficient. Long droughts causing serious effects on the island's economy, were frequently attested. A handwritten testimony of 1468 describes one of these. It lasted throughout winter and spring. The original text and translation follow:

*"εἰς τὸ νυσσὴν τὴν Κύπρον μία μεγάλη ἀνομβρία ὥστε οὐκ ἔβρεξεν εἰ μὶ ὅλον τὸ χειμονικὸν… Αἱ τῶν ὑδάτων ἀπεξηράνθησαν πήδακες καὶ ποταμῶν ἀεννάων ἐξέλυπε ρεύματα καὶ* οὔτε οἱ *μύλοι ἀλέθασιν* οὔτε *αἱ πηγαί ἔβλυζον,* οὔτε *χόρτος ἔφυε καὶ τὰ ἄλογα ζῶα ἐλυμοκτονίσασιν…" (Rizopoulou- Igoumenidou 2006,91)*

*"On the island of Cyprus there was a huge drought, without rainfalls during the winter… The water in the wells dried up, the eternal rivers lost their streams, the mills could not grind, the springs no longer gushed water, the grass did not grow, and the animals were starving …"*

Such phenomena, led to the construction of organized water systems. Sugar cultivations required large tracts of land and massive investments for the construction and maintenance of aqueducts. In addition, extensive regulations regarding the management of water consumption were applied. As cited in Chapter 5, water caused a long dispute between the Cornaro family and the Hospitallers.

During the Ottoman period, agriculture was still the primary source of the economy of the island. Sugar production, however, was gradually replaced by cotton plantations. Undoubtedly, Cyprus, laying in the crossroads of the shipping routes, owes the political, military and commercial importance it gained during the centuries, to this unique geographical location, which was often the "apple of discord" among foreign powers.

## *Chapter 3*

## *Architecture and technology in Cyprus*

The production of sugar is a complex process with a series of steps. In order to examine the archaeological findings, it is essential to comprehend the procedure. The first descriptions of sugar production derive from the encyclopedists of the 18th century (Diderot 1765, 608-614). The production process of cane sugar was an arduous work, which required a sequence of time-consuming and complex operations. Firstly, the cane, when it reached three to five meters in high (Smith 2015,10) almost three months after its blossoming, was cut. Then the cane sugar stalks were crushed in mills or presses in a refinery. The juice extracted from the canes was boiled in large cauldrons, and the sugar and syrup were collected. Bagasse, i.e., the dried cane residue waste, was often used as a fuel for the boiling process. Next, sugar and syrup were drained into cone-shaped clay moulds, where the sugar was crystallized, and the remaining liquid ended up in molasses jars. The moulds had to stay in a shady place for 15 days (Cordoba and Muller 2011, 283). In the final stage, the product was sold in the form of loaves or pulverized lumps (Jones 2016,17). Almost every step of this production sequence was illustrated by Giovanni Stradano (1636-1605) (Fig.2).

The preceding procedure was also, partially described by Seigneur de Villamont who in 16th century visited a village in Cyprus, not mentioned by name (Cobham 1908,174):

*"We went down to see the sugar canes, and the house where they are made into sugar. But I need not describe this, for everyone knows about it. Only this much, that the water which flows down from the garden turns the wheel which crushes the canes, and the liquid thus expressed is boiled to make sugar."*

In the following pages, the archeological findings from the three most well-preserved sugar production centers in Cyprus are presented. A comparative study of these three centers will be carried out by tracing similarities and differences of the "Cypriot master plan" as it was described by one of the excavators (von Wartburg 2014, 216). In addition, a comparative study of other sugar production

centers in the Mediterranean will be conducted to determine the possible origin of the facilities and technologies used.


Figure 2: Giovani Stradano, "Saccharum", 1580-1605. London, British Museum. https://www.britishmuseum.org/collection/object/P_1948-0410-4-203, accessed on 2 July 2020.

### *3.1 Kouklia-Stavros Sugar Production Center*

In the Paphos region, 16km east of the city of Paphos, at Kouklia, one of the most integrated and well-maintained sugar cane production complexes was discovered during the 1980s and 1990s, when a Swiss-German expedition started excavating in this district of Cyprus (von Wartburg 2001, 305). The mild climate and the fertile valley, crossed by river Diarizos, favored the agriculture of various crops, including sugar cane. In the Paphos region sugar plantations are attested in the villages Lemba, Emba, Kouklia and Akhelia (Solomidou- Ieronymidou 1998,65).

The first evidence of sugar production in the area was the great quantity of pottery used for it and a few remains of refinery buildings revealed in the excavations at the Temple of the Paphian Aphrodite (von Wartburg 1983, 299-30). Parts of the

boiling installations that were found are fragmentally preserved; hence little information is available from this area. Remains of an aqueduct are preserved at the sanctuary site, the Manor House and the sugar refineries. In the end of the 19th century the French researcher Enlart had noticed that several sections of gothic aqueducts were built between the Royal Manor and the sea for use at the sugar factory:

*"plusieurs troncons d' aqueducs gothiques… construits pour l'usage de la fabrique de sucre"* (Rizopoulou-Igoumenidou 2006,88).

*"Several sections of gothic aqueducts ... built for the use of the sugar production"*

Two sugar cane refineries, classified as TSTI which entails milling, boiling and storing units and TSTII where rooms for sugar cane refining are preserved, were revealed at the coastal area (Fig. 3).

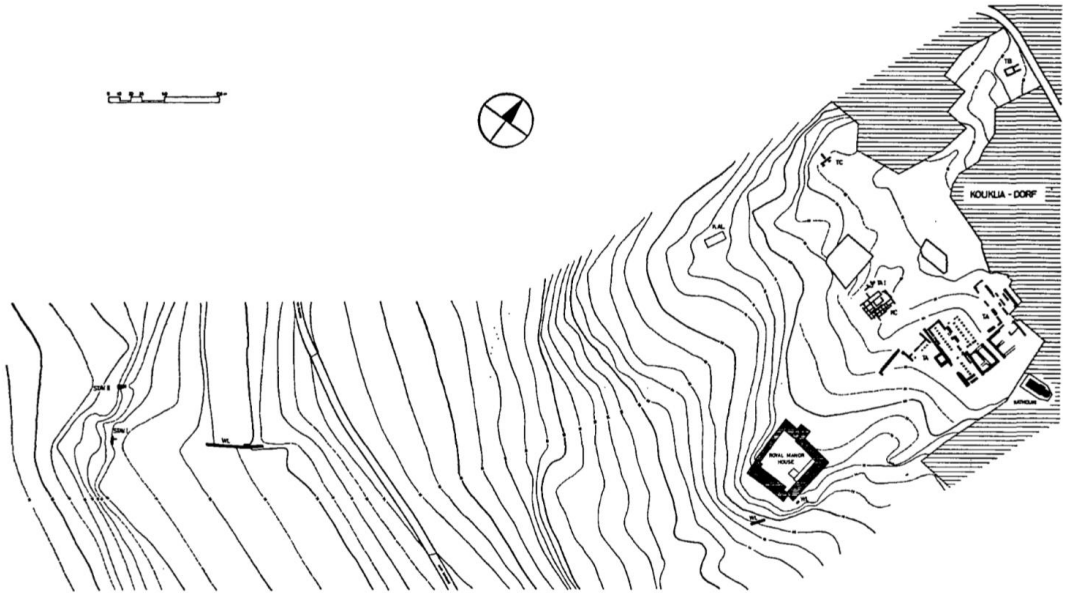


FIG. 4. Kouklia: the area of the medieval cane sugar installations. TA, Temple of Aphrodite; TA I, Ayios Nicolaos; TB, Roman house; TC, House of Leda; KC, Roman peristyle house; K.AL, Roman house (in Kato Alonia); WL, part of medieval aqueduct; STAV I and II, cane sugar mills at Stavros

Figure 3: Sugar cane installations at Kouklia (von Wartburg 1983, 302)

The TSTII consists of three spaces, including a water mill for the grinding of the sugar cane. This sector seems to have been used as an auxiliary space, where a first crushing took place (von Wartburg 1983, 304). Apparently, the production of sugar

was enormous, and many facilities were needed. The TSTI is composed of four sectors, according to the needs of the productions: milling, boiling and refining, firing and stoking, and storing (Fig.4). In the plan, it is noticeable that each area of the production had a definitive function, which allows us to delineate the complete sugar refining process.

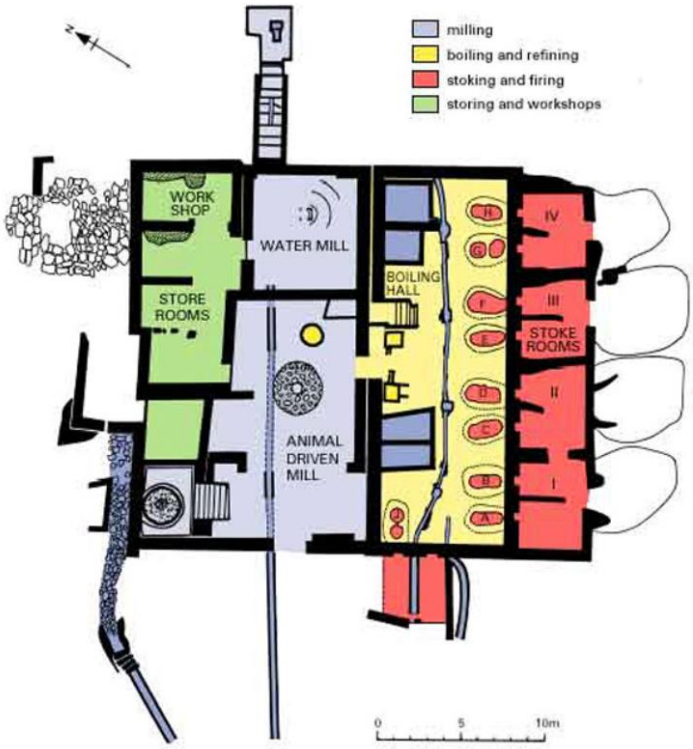


Figure 4: Plan showing the sugar refinery (TST1) at Kouklia-Stavros (von Wartburg 2015, 149)

The milling sector comprises of a so-called special milling device in a subterranean room in the north-west, a grinding hall with a crushing mill driven by animals in the center, a watermill in a vaulted subterranean chamber in the east of the complex and some unstratified presses.

The special milling device and the horizontal watermill belong to the initial phase of the building, which dates in the late 13$^{th}$ century, while the animal-driven mill situated in the hall correlates with a later reconstruction during the 14$^{th}$ century (von Wartburg 2015, 152). The exact function of the underground milling device was till recently vague (Fig.5). In the primarily plan published by von Wartburg this room was initially labelled as “Press” and the only identical finding referred was an iron

block, which had been interpreted as “a piece used to secure an upright shaft” (von Wartburg 2001,333). Five years ago, the excavator illustrated the mill base thoroughly (von Wartburg 2015,153-156). From the latter excavations, it is revealed that the north face of the mill is incorporated in the north wall. The wear traces found in the mill indicate the use of one or two edge runner stones that were rotated on it. In addition, a well-maintained underground canal was found in the north-western corner, while it was revealed that the north wall extended to 1.80 meters below the floor level. The above evidence led the excavator to suggest that a vertical water wheel operated in this room. It has been proposed that the horizontal shaft drove a wooden gearing machinery, which was situated above the milling device (Fig.6). The water was thrown on the wings of the vertical turbine which put into motion the turbine along with the central axis of the water wheel. In its turn the central axis rotated the gear which was attached to it. This gear was engaged with another horizontal gear which would spin the drive shaft of the grinding mechanism. The excavations revealed that this section was abandoned and replaced by the mill operated by animals in the central hall of the complex.

Figure 5: Mill base on the west part on the room at Kouklia-Stavros (von Wartburg 2015,153).

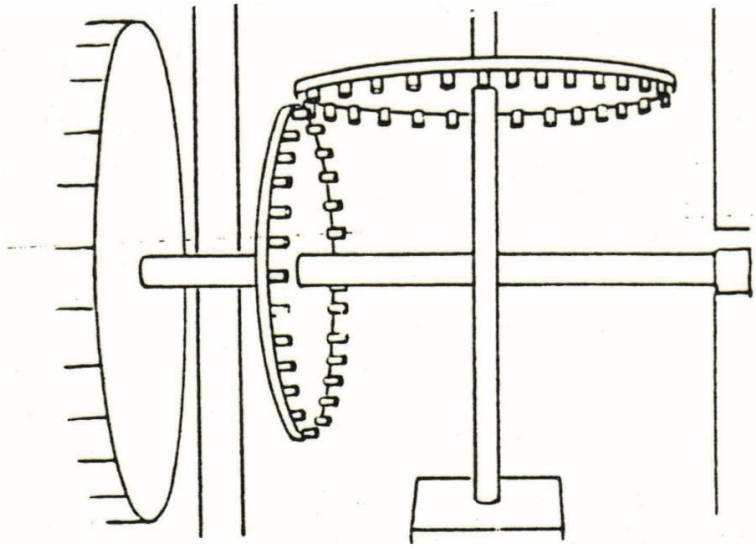

Figure 6: Sketch of the gearing mechanism (von Wartburg 2015, 154).

The limitation of this survey lies in the fact that the access to the archaeological site and to the detailed excavation diaries is restricted. In that respect, I assent that a vertical water mill operated in this room. However, issues related to the origin of this technology, the reasons why this type of machine was preferred and the explanation behind its abandonment need further investigation. The main aim is to scrutinize whether this milling technique was introduced by the newcomers or pre-existed in the island or if it was coming from the East.

The exploitation of hydraulic energy was definitely the most important step in the grinding procedure. Abundant written and archaeological evidence for the existence of watermills is preserved from the ancient world. The earliest testimony derives from Strabo (64 BCE) who described the *ὑδραλέτα* at Cabeira, in Pontus (12,555) seen by Pompey's troops. The contemporary epigrammatist, Antipater from Thessaloniki (1st century BCE) provides a poetic description of the function of watermill for grinding[7], while Vitruvius (10.5.2) describes its construction. The

[7] "Hold back the hand that works the millstone, women grinders;
Sleep long, though the cock's crow proclaims the morning twilight.
For Demeter has enjoyed upon the Nymphs the labors of your hands;
And they, leaping upon the wheel's topmost part, whirl the axle, which revolves
With its twisting rays the hollow weights of the millstones from Nisyros. We taste again the joys of our fore-fathers' life, if we learn to feast without labour on Demeter's works." AP9.418 (Gow, Page 1968,63).

most well-known archaeological evidence of water mills from the Roman period is attested in Venafro, in southern Italy and in Barbegal at France.

The invention of the vertical watermill and the chronological order of the vertical and the horizontal water mill has been a vague and controversial matter of debate. Nowadays, it is broadly accepted that both vertical and horizontal watermills are dated in the Graeco-Roman period (Shulman 2017,29; Germanidou 2014,185; Lucas 2006,15; Lynch and Rowland 2005,44). However, it has been supported that the Greeks and the Romans did limited use of waterpower technology (Lynch and Rowland 2005,41; Gies and Gies 1994,35) and that the fast diffusion of watermills during the medieval times was characterized revolutionary (Gimpel 1976)[8]. Recent research has revealed that there is a wide diffusion of water-powered grain mills in the Roman world as well (Wilson 2020). It has also been stated that different types of watermill technologies were used during the same period (2nd cent BCE) in China (Lucas 2006,15). The issue of the diffusion and the development of watermill technology is ambiguous, and it is not intended here to make any further comment to this long-lasting debate, but to stress that the watermills were invented and were in use many centuries before the medieval period.

In medieval Europe the vertical watermills were widely employed (Germanidou 2014,199). Nevertheless, the horizontal watermills also operated in some areas, such as Ireland and Denmark (Lucas 2006, 39-41). Generally, vertical watermills were operating where the availability of vast quantities of water, and large capital needed to make such machines, existed. They were usually placed next to rivers in order to serve large urbanized communities (Lucas 2006, 41). On the contrary the horizontal watermills were of a simpler construction, as no gearing was needed, hence they were cheaper. Moreover, less amount of water was required for their operation, thus they were suitable for mountainous territories. In Islamic societies watermills have existed since the 7th century (Lucas 2006,65). The first record of a Cypriot water mill dates from the 12th century (Ionas 1994, 439).

Focusing on the watermills used in sugar production, similar vertical watermills in the process were found in the island of Rhodes, Greece. The sugar production in

[8] For more details in the medieval narratives concerning medieval technology see at Lucas 2010.

Rhodes was introduced by the Knights of St. John (1309-1522) who established a sugar production center in the site Zacharomylos (Kollias and Michaelidou 2004, 15). In addition, installations of sugar mills were found in Montfort Castle in Palestine. However, it is questionable whether they were vertical or horizontal. According to Pringle, if a vertical waterwheel existed in this place it should be connected with the Franks, who were supposed to have introduced this type of mill to this area in which the use of horizontal watermill was widespread (Pringle and Leach 1986, 70).

The assumption of Pringle is verified by the archaeological evidence in Cyprus. The construction and maintenance of vertical watermill requires financial resources, and even since the early medieval period this type of mill has been linked with wealthy owners (Suatriti 1998, 136). In this respect, the Lusignans were undoubtedly the ones who could afford such constructions and therefore the vertical watermill in sugar production could be associated with the Crusaders.

Now the origin of the vertical mill in sugar production has been identified, the next step is to explore the reasons behind its use. The watermill played a pivotal role in the economic evolution and as already mentioned the vertical water mill is considered to produce surpluses and to be more powerful and efficient (Rünger 2019, 115). Although, the Lusignans were familiar with sugar cultivation in Syria and Palestine, they chose to experiment. The financial demands were not an obstacle to their plans, neither was the technological knowledge. However, for Cyprus the supply of water stood as a significant barrier. During summertime, Cyprus was suffering from droughts, therefore relying only on waterpower was risky and potentially disastrous for their enterprise. This also stands as an explanation behind the early abandonment and replacement of the vertical watermill by an animal-driven mill. The reason why the horizontal water mill was used instead of the vertical was because the vertical watermills required large quantities of water in order to operate successfully (Lucas 2006, 36; Harvey 1990, 129,133).

In the center of the grinding hall, a large mill-base driven by animals was discovered (Fig.7). The animal driven mills are attested in 4$^{th}$ century BCE in Greece (1.5.5), while the earliest mention in China is dated before 175 CE (Lucas 2006, 22).

However, these mills had no gearing mechanism which was excessively used during the Middle Ages in Western and Northern Europe.

Figure 7: Animal- driven mill at Kouklia-Stavros (von Wartburg 2015,149)

As von Wartburg, the excavator had noticed, archaeological evidence verifies the two phases of the milling process as they were described by the Egyptian author al-Nuwairi (1279-1332) (von Wartburg 2001,316):

"*The sugar canes are laid under the millstone which is turned by good oxen, and through that the cane is squeezed out ... When the canes are pressed out as much as possible, they are transferred to another place. The pulp is packed into baskets made of rushes, with slits on the sides and at the bottom. These baskets are put under the wheel which is moved by beams, until the pulp is completely crushed and the last juice has flown out of it"*

The animal driven mills were also used in the grinding process of other crops such as olives (Cordoba and Muller 2011, 282). This type of mill used in sugar cane production existed till recently in India, as illustrated in the 20th century photo below (Fig.8). [9]

[9] Even today people crush sugar in India's street using animals as a driven force. See at https://www.youtube.com/watch?v=xLi5-TNdNag, accessed on 2 July 2020.

Figure 8: Old-fashioned Indian Sugarcane Press, c.1905
https://digital.lib.uh.edu/collection/p15195coll29/item/121, accessed on 2 July 2020.

In the north part of the Kouklia-Stavros hall, another watermill dated from the earlier phase of the building was revealed inside a vaulted subterranean chamber. Before examining the milling device, it is imperative to point out the existence of an aqueduct behind the milling room. The aqueduct has the shape of a pressure channel which supplied the mill with water.

A sophisticated irrigation system was constructed in order to supply the cultivations and the refineries with the most precious commodity, water. The construction of such complicated system and facilities required a large investment. The landowners and the human forces behind this system are thoroughly investigated in Chapter 5. The springs of Oridhes forest supplied the aqueduct with water in order to irrigate the plantations and to set the mills in power. loannes Cotovicus, a Doctor of Civil and Canon Law in the University of Utrecht, sailed to Cyprus at 1598 and referred to the established irrigation system:

*"It was once called Porphirusas: now it is a village, by name Couclia, whose well-watered fields abound in grain, cotton and sugar."* (Cobham 1908, 193**)**

The watermill was located in the vaulted subterranean chamber. Its existence is verified by the wheel marks which are still visible in the floor (Fig.9). These marks led the excavator to propose that a horizontal waterwheel mill was based in this place (von Wartburg 2001, 317-318). More specifically, the type of mill used was the edge-runner mill.

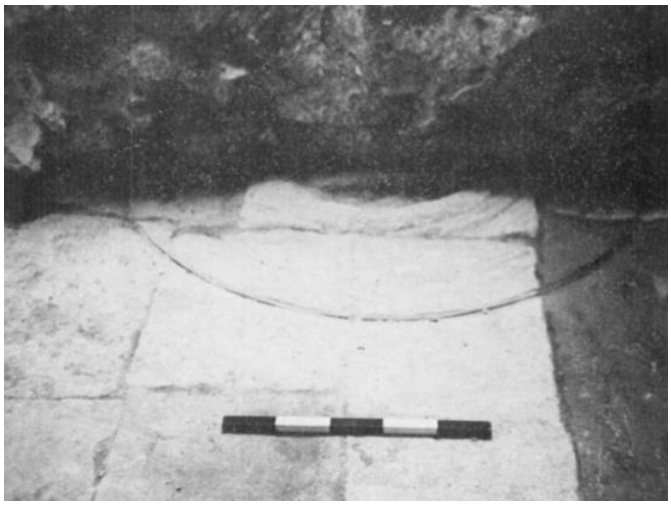

Figure 9: Wheel-marks at the subterranean room at Kouklia-Stavros (von Wartburg 1983, Plate XLVI)

The edge-runner mill was composed of a horizontal water wheel with a vertical shaft on the ground level and of the millstones, where the sugar canes were crushed, in the level above. The upper stone was the edge-runner stone, which was rotating and was adjusted in the bed millstone. This mill was used in order to crush the canes instead of grounding them, as grounding was a practice used mostly in grain. The crushing was used in the sugar canes because it was more efficient to extract the most syrup. The water was poured from a pipe high above the mill, still partially visible today, on the wings of the wheel and forced it to rotate. Along with the water wheel, the central vertical pole and the vertical edge-runner mill, which is connected with the upper milling machine, revolved. Thus, the speed and the frequency of the water determined the sugar crushing process (Wikander 2000, 375). This type of mill emerged in China in the 5$^{th}$ century CE and arrived in Europe in the 12$^{th}$ century (Gies and Gies 1994, 89). This system is clearly illustrated by Juanelo Turriano in 1560 (Fig.10).

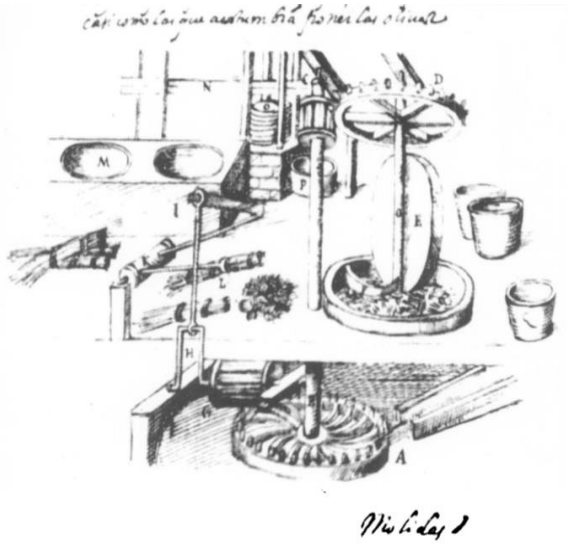

Figure 10: Drawing of Juanelo Turiano (after von Wartburg 2001, 320)

After crushing the canes, the juice collected was boiled in a boiling sector. The liquid was poured into basins, which at Kouklia were located in a large vaulted room next to the milling area. A water conduit crossed the center of the hall and the boiling installations were situated at the south wall of the room. Today, in this wall, four pointed arches are evident. Underneath them a pair of hearths is attached to each arch (Fig.11). Although it has been proposed that there was a shortage of wood during the 15th century in Cyprus (Ouerfelli 2008, 271) the analysis of the charcoal preserved at the hearths revealed that pine, oak, mastic and carob were used as a fuel (von Wartburg and Maier 1989, 182). Above the fireplaces, large copper cauldrons were placed. Unfortunately, the cauldrons are not preserved in Cyprus. Their existence is known from the neighboring sugar factory at Safi, Jordan (Politis 2010). However, among the findings, the huge quantity of sugar pottery, which is examined in the next chapter provides useful information about the sugar production process.

The firing and stocking rooms were situated behind the boiling sector. This area was completely disconnected from other sectors in order to protect the sugar from the impurities derived from the smoke. These rooms were accessible only from the exterior side of the complex. At the north end of the complex, the storage areas were revealed. The excavation reports, however, reveal scarce information about these rooms.

Figure 11: Boiling and Stocking installation at Kouklia-Stavros (von Wartburg 2001,323)

The archaeological evidence demonstrates that the sugar refinery was built in 13th century. The written sources reveal that it firstly belonged to the Lusignan family and later in 1489 it was accredited to the Martini Brothers from Venice (von Wartburg 1983, 310). The sugar refinery operated till 1600 and gradually the sugar plantations were replaced by cotton plantations.

### *3.2 Kolossi Sugar Production Center*

Kolossi is located west of the city of Limassol, in a fertile valley where the Kouris river transverses and watered the sugar cane, wine, olive and cotton plantations. The excavation of the sugar production center was conducted by the Department of Antiquities in Cyprus in 1994 (Solomidou- Ieronymidou 2005, 45).

In 1210, Hugh I of Lusignan (1195-1218) the king of Cyprus, provided special benefits to Hospitallers. Kolossi was one of the properties that was granted to them (Coureas 2013, 215). This is also verified by the archaeological evidence of a marble lintel, which bears two coats of arms, one of the Order of Saint John of

Jerusalem and the other of Louis de Magnac, Grand Commander of Cyprus, which was found in the milling room (Solomidou-Ieronymidou 2015,61).

The sugar production at Kolossi was first mentioned by Joan Benet, a Catalan merchant in 1343. However, it has been proposed that the production began much earlier (Plana 1992, 117). The sugar refinery at Kolossi was renovated in 1591 under the rule of Murad Pasham (1535-1611), as attested by the inscription discovered on the south side of the refinery (Solomidou-Ieronymidou 1998, 68). Martin von Baumgarten, a noble from Tyrol, who went as a pilgrim to the Holy Land, stopped in 1508 in Cyprus. He visited Kolossi and he described the sugar cultivations and the exact port at which they obtained the sugar (Cobham 1908,55):

*"We sailed by Colossus, a village of Cyprus, remarkable for its great plenty of sugar…*
*Leaving Nycossia we went on to the mountain of the Holy Cross, on the summit whereof is a convent of Greek monks. Here is the cross of the good thief; and we saw as far as the pier of Minesse where our vessel lay. And from Minesson we journeyed along the seashore to the port of Basphe, for our ship was going there to load sugar and cotton."*

The sugar production center is situated next to the tower of Kolossi. Burkiewicz proposed that the sugar mill was built next to the tower for safety reasons (Burkiewicz 2016,125). Undeniably, sugar was a high valued product. Nevertheless, the fortress seems to have functioned more as an administrative center rather than as a defense building. The architectural structure of the building (Fig.12) is similar to the one of Kouklia- Stavros, which has already been described. Although the milling, boiling and stocking rooms exist, storerooms have not been testified and are yet to be discovered.

As previously discussed, water is precious in all stages of sugar production, both for the irrigation of the plantations and the operation of the mills. Thus, the Knights of Saint John built an irrigation system which transferred water from river Kouris. The river Kouris provided water also to the Cornaro family, who owned the sugar factory at nearby Episkopi. It is easy to imagine that conflicts might have occurred between the two owners. Similarly, it is known that Hospitallers owned sugar

plantation in Acre and they were in constant dispute over water distribution with the Templars, who also possessed plantations in the area (Jones 2016,33). The accessibility to water resources was a constant bone of contention. Regulations for the water management existed on the island as indeed in later centuries. In 1829, people could have access to water only for certain hours (Rizopoulou- Igoumenidou 2006, 99*)*. These regulations, having deep roots in time, seem to have remained until the 20th century, when Cyprus was under English rule. Analogous rules relating to the rights of water also existed in Palermo, another area of sugar production (Ouerfelli 2008,160).

In the milling sector, there was again an animal-driven mill and a horizontal watermill. The watermill is situated at the south of the aqueduct. The existence of a horizontal instead of a vertical watermill is verified by the discovery of parts of the wooden turbine wheel in the subterranean chamber (Fig.13).

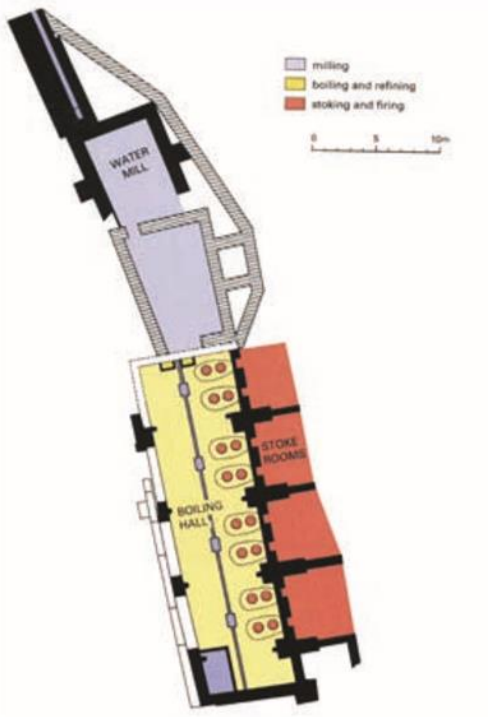


Figure 12: Plan showing the sugar refinery at Kolossi (von Wartburg 2015, 150)

Figure 13: Part of the wooden wheel at Kolossi (Solomidou- Ieronymidou 2005,49)

Similar milling rooms which date back to the Ayyubid period were found in Jordan. Jordan Valley was a place of huge sugar production during the medieval period and this is verified archaeologically by the remains of 32 water-powered sugar mills (Hamarneh 1976, 221). The horizontal watermill found at Safi resembles the ones in Cyprus (Fig.14). The fact that these mills are from a slightly earlier period and are widespread throughout the region led some researchers to propose that sugar production in the Mediterranean arrived as a 'package' from the Near East (see Chapter 5). Indeed, we could support that the horizontal watermills in Cyprus were established by people who settled on the island during the Frankish period.

Figure 14: The Masna'al-Sukkar in the Ghor as-Safi, Jordan Valley, 12th century (Politis 2015, 33)

Except for the watermill devices, presses from the later period of the construction of the sugar factory have also been discovered (Fig.15b), which were commonly used in the crushing of olives in the Roman period. The Latin term used to describe this press is *trapetum*, from which the word *trapiches* is derived. *Trapiches* was the word which defined all kinds of mills used for the grinding of sugar cane in the Americas (Schwartz 2004, 52-53). Ouefrelli, in his work, also uses the word *trappeti* in a broader frame to describe the sugar mills in Sicily (Ouerfelli 2008,729). Although various meanings are given to the word *trapetum*, it should be noted that the primary meaning is associated with the pressing (and not milling) of olives.

Presses were also identified in the Levant. In Lower Harbot Manot in Western Galilee, a press, which already existed from the Byzantine period and was related to wine production, was later reused in sugar refinery for sugar cane pressing. This type of press, being uncommon to the area, was named as "Manot Press" (Stern 2015, 91). In Lower Harbot Manot, it has been proposed that this kind of screw press was introduced by the Crusaders (Frankel and Stern 1996). However, these kinds of presses were widely known in the region already from the Byzantine period ($4^{th}$ -$7^{th}$ centuries) and were consequently in use during the Islamic period ($8^{th}$-$9^{th}$ centuries) (Taxel 2013,361-362). Of course, during the earlier periods, these presses were used for wine and olive oil production, but on the advent of sugar cane production, this technology was adapted for the new crop.

The Press's function has not been described by the excavators neither in Cyprus nor at West Galilee. We should, however, imagine that they operated in a similar way with wine and oil presses. Taxel in his research suggests four types of presses, which could also be matched to the ones at Kolossi (Fig.15a).

Figure 15: a. Four kind of presses. 1. Lever and weights press; 2. Lever and screw press; 3. Direct screw press with grooved stone piers frame; 4. Direct screw press with a hewn cross-shaped frame (after Taxel 2013,362)
b. Press from Kolossi (Solomidou-Ieronymidou 2015,142)

The boiling area, similar to Kouklia, is situated adjacent to the milling section. Eight fire chambers were discovered along the east wall of the large vaulted room (Fig.16). In addition, at the south corner of the complex, a cistern which was later converted into a rubbish pit was revealed, where a large number of intact moulds and jars were found. The reason why these vessels were found there is discussed in the following chapter. Finally, findings in this room have revealed that it was converted into a metallurgical workshop after its abandonment.

Figure 16: Boiling installations at Kolossi (Solomidou- Ieronymidou 2015,140)

So far, significant differences could be identified in the architectural and technological plan of the two sites. A comparison of the two first sugar factories show that the milling sector is composed of the same devices, except for the vertical watermill which is attested at Kouklia**.** The boiling and stocking rooms are identical with the ones of Kouklia, but the storerooms are absent at Kolossi. The archaeological findings from Episkopi, explained below, complete the overall idea of the architecture and technology in Cyprus.

### *3.3 Episkopi-Serayia Sugar Production Center*

The sugar production center at Episkopi is located at the site Serayia, at the southern edge of the Episkopi village in Limassol district. According to Archimandrites Kyprianos, before 15th century, the village was known as La Piscopia dei Cornari, as it was granted to the Cornaro family by the Lusignan King of Cyprus Peter I (1328-1369) (Αρχιμανδρίτης Κυπριανός 1971). This information is also confirmed by Count Gabriele Capodilista, who visited Cyprus in 1458, and informs us that:

*"they reached a little village called Episcopia, very rich in sugar, which belongs, I think, to some Venetian gentlemen of the house of Cornero…they saw many fields of sugar cane : and these gardens and fields are watered by running streams, and bulbs and squills grow there in abundance."* (Cobham 1908, 35).

From the written sources it is known that although the sugar cane plantations declined in 17th and 18th centuries to be replaced by cotton plantations, they had been kept in memory. Cornelis van Bruyn, in 1683 describes the village:

*"Bisschopia is a fine level plain with many ancient ruins. It is watered by a river and is said to have produced formerly sugar-canes in abundance. Now it is planted with cotton."* (Cobham 1908, 241).

The excavations of the sugar refinery, which initiated in 1988, lasted until 1997 (Solomidou-Ieronymidou 2015, 158). A unique medieval manuscript plan of Episkopi dating from 1551 provides significant information confirming the archaeological evidence (Fig.17). Some of the installations revealed were described by the author of the Travels of Ali Bey, who visited Episkopi in 1806 and writes:

*"It was formerly a very rich town, with large sugar-works. One sees still the ruins of an aqueduct, immense stores or vaulted halls, and several Greek churches with fresco-paintings."* (Cobham 1908, 404).

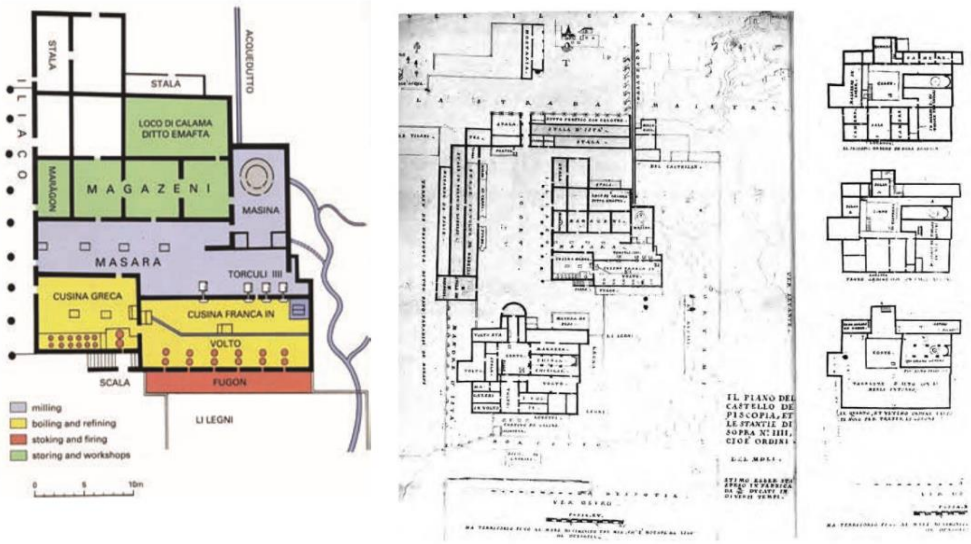


Figure 17: Plan showing the sugar refinery at Kolossi on the left and the overall Plan of the Castello de Piscopia, 1551 on the right. (von Wartburg 2015,151)

In contrast with the previous two sites, in the milling sector at Episkopi only presses were found and no animal-driven mill. The fact that the presses of Kolossi and Episkopi belong to a later period (14th century) might indicate that the ones found at Kouklia were also introduced in a later period. Moreover, it might indicate that this 'new' technology was associated with Venetian rule. In line with the drawing, this room was named *Masara*. The word *Maasara* is an Arabic word that was used to designate the place where the sugar cane was crushed or where the sugar mill was placed or even where sugar was stored (Kollias and Michaelidou 2004, 16). *Maasara* is also known as the name of a place probably indicating the presence of a mill. Moreover, this word was used by Western Europeans to name the olive, wine and sesame presses. The fact that this word was adopted by the West and used

excessively, indicates the interconnection of the Arab and European world, a practice that is apparent in every place where different populations co-existed.

In all the three sites the horizontal watermill is present. In Episkopi, this room was named *Masina*. This word probably comes from the Italian word *macina* and suggests the place in which the milling device was housed. Similarly to Kouklia and Kolossi, a subterranean chamber housing the water-wheel and a second floor with the grinding stones were discovered. Above and at the north-western corner of this milling room, an aqueduct and a pressure channel came to light.

Another large paved room named *Magazeni* was discovered, at the north part of the complex. In modern Italian *Magazziniere* means warehouse, thus, we can assume that the storerooms were located in this area, where probably the packaging of sugar was taking place.[10]

Unlike at Kouklia and Kolossi, at Episkopi two boiling rooms were discovered. The first one was named *Cusina Franca* and is composed of eight chambers with two hearths in each, instead of six chambers that are depicted in the drawing. The two extra chambers might have been added after the creation of this drawing. The extra chambers in *Cusina Franca* and the additional room named *Cusina Greca*, indicate the considerable need of extra boiling space. Moreover, a water cistern was discovered at the eastern side of *Cucina Franca*. The presence of an extra boiling room was explained by the excavator as due to the need of obtaining sugar of better quality (von Wartburg 2014,241). It is known from the written sources, that a better sugar quality can be acquired when the sugar is boiled many times. Evidence that Venetians invested in the boiling sector is also supported by the import of two big copper cauldrons from Venice (Aristeidou 1990, 1).

The attributions *Greca* and *Franca* before the noun *Cusina* is yet something unexplored. Finally, the firing and stocking rooms were similar to the ones in Kouklia-Stavros and Kolossi.

[10] The packaging at Episkopi was made of *cannavacio,* a thick cloth that covered the sugar (Aristeidou 1999, 97).

### *3.4* Concluding Remarks

On the basis of the material presented in this chapter, a number of tentative observations can be made about the technology used in the sugar cane process between the late 13th and 15th centuries.

Concerning the milling sector, a common feature among the three sites is that they have a horizontal watermill. It has been proposed that the knowledge of the technology of this milling device, along with the know-how of the construction of the irrigation system is connected with immigrants to Cyprus in the 13th-14th centuries. Indeed, as it has been proved by the earlier production centers in Jordan, the horizontal watermills used there were exactly the same. Therefore, we could deduct that the technology of the horizontal watermill derives from the Near East.

However, among the three sites in Cyprus there are significant differences. The analysis in this thesis provides evidence that the vertical water mill in Kouklia is associated with the Crusaders. Moreover, the animal-driven mills existed only in Kouklia and Kolossi. In all three sites presses are attested. The ones in Kouklia are unstratified, yet due to the connection with the Martini Brothers from Venice (it is known that in 1461 the sugar produced at Kouklia was contracted to them) this should be taken into consideration (von Wartburg 1983, 310). Since the presses replaced the animal-driven mills in Episkopi, which was under the Venetians and those found in Kollosi were also introduced in the later Venetian period, this might indicate that the ones at Kouklia could also have been constructed by the Venetians.

From the above we can conclude that both the Franks and the Venetians, seem eager to experiment with already known technologies, which they used for the first time in their sugar production (Table 1). They had the capital required to do so and the reason behind their attempt to explore other technologies was due to their wish to make more profit. We should not forget that sugar production was a lucrative business and its marketing target at the time was only for the elites.

In the boiling sector the installations are the same at all three sites with only the number of the hearths varying from six to eight. The difference occurs in Episkopi, where two, instead of one, boiling rooms are testified. The reason for this extra room, as explained by the excavator, was that the more the sugar was boiled, the

better quality it acquired. Episkopi seems to have experimented the most and we could assume that competitive reasons may be hidden behind this finding.

| **KOUKLIA**<br>**Lusignan Family**<br>**(13th-16th)** | **KOLOSSI**<br>**Hospitallers**<br>**(1210- 16th)** | **EPISKOPI**<br>**Cornaro Family**<br>**(1367-16th)** |
|---|---|---|
| "Special milling device"- "Press"- Vertical Water Mill | Animal driven mill | Presses |
| Animal-driven Mill | Horizontal Water Mill | Horizontal Water Mill |
| Horizontal Water Mill | Press | |
| Unstratified Presses | | |

Table 1: Milling devices at Kouklia-Stavros, Kolossi and Episkopi-Serayia

In order to answer the questions presented at the beginning of this thesis, whether there is a "Cypriot Master Plan" or not, we should notice that the three sites are composed of four sectors (milling, boiling, stocking and storing) which are necessary for sugar process[11]. However, there are significant differences in the milling and boiling sector among them. The different technologies are inevitably connected with artisans who master them. The horizontal mill is associated with Near East production; the vertical mill with the Franks; and the presses and the extra boiling rooms with the Venetians. Although, the Lusignans were familiar with sugar cultivation in Syria and Palestine, the Hospitallers held sugar production properties in the areas of Beirut, Sidon, Tyre and Acre and the Venetians were active in sugar production in Syria at least since 1240 they all chose to experiment with new

[11] Although the storing sector has not been discovered yet at Kolossi, it is assumed that it existed.

technologies. The reason why the Franks, the Hospitallers and the Venetians chose to establish new technologies could be testified in the economic benefits that sugar production had. They invested their money in new technology in order to enhance their revenues.

## *Chapter 4*

## *Pottery in Sugar Production*

Ceramics, being the most numerous findings in an excavation, could not be missed from this research. In the previous chapter, the technology employed, and the architecture followed was analyzed. This chapter examines the sugar vessels found in Cyprus on sugar production sites. The Cypriot sugar vessels and reference pottery from selected sites around the Mediterranean are compared in order to trace the technology of this pottery production, the provenance of the technological knowledge and the exchange networks.

Figure 18: Three types of sugar moulds and molasses jars (von Wartburg 2015,160)

### *4.1 Sugar Pottery from Cyprus*

A fundamental research investigating the sugar pottery of Cyprus was recently published by von Wartburg, one of the excavators at Kouklia (von Wartburg 2014). The study focuses on the typological analysis of 114 moulds and 47 jars found in Kouklia-Stavros site, more specifically in the sanctuary of Aphrodite (TA), the Manor House (CH) and on the coastal plain where the main refinery (TST) is located (Fig.3). Unfortunately, only the pottery from Kouklia has been examined in depth, therefore, my research compares this site with Mediterranean sites and not between Kouklia, Kolossi and Episkopi.

The pottery found in sugar production sites in Cyprus consist of two different forms; the moulds which are funnel-shaped vessels with a circular hole in their base and the molasses jars, which are found in diverse shapes, yet sharing similar characteristics such as a round base and a narrow neck. As mentioned in the previous chapter, once the sugar syrup is boiled, it is poured into the moulds, which are supported above the jars. The sugar is crystallized in the moulds and turns into sugar loafs, while the remained liquid ends in the molasse jar underneath.

Concerning the raw materials used for their construction, both vessels are made of levigated fabrics containing mainly small to medium size inclusions of sand and limestone. The firing is medium to medium-hard, and small voids regularly exist. Due to their function, jars are made of a harder fabric as they support the moulds. Regarding the forming and finishing techniques, moulds and jars are both unglazed and wheel made. The wheel marks on the exterior of moulds and the molasses jars are evident. The moulds have an extra characteristic; their interior is smoothed. After the sugar was crystallized it had to be removed from the vessel. Therefore, it was easier to be removed when the surface was smooth (von Wartburg 2014, 224). It has been proposed that in an earlier stage the moulds were broken in order to acquire the sugar (Jones 2016, 62) a view supported by the huge amount of broken pots found in the refineries. A relevant excessive amount of broken pottery fragments was also found in Kouklia. However, it is difficult to support that these fragments are from an earlier period, as stratigraphic evidence is not clear (von Wartburg 2014, 217).

An issue of investigation was to find the site of production of these vessels. In the excavated Late Bronze Age part of the Sanctuary, a round pottery kiln linked with sugar pottery was revealed. In addition, a kiln related to sugar production has been found at Episkopi (von Wartburg 2014, 217). Understandably, the pottery manufacturing was really close to the sugar production centers. In many instances glazed ceramics were also detected next to the sugar pottery. Their discovery is essential, as they provide a date for the pottery used in sugar production indicating that in these workshops the potters had not specialized only in one kind of pottery making.

In the pioneering research of von Wartburg, the moulds and the molasses jars were categorized according to their shape and size. The moulds were divided into 3 types concerning their height and rim diameters; small, medium-sized and tall moulds (Fig.18). Each one of them has three sub-groups.

Type I entails the small moulds, which are subdivided to three groups regarding the variety of their height which ranges from 14cm to 23cm and the rim diameter from 10 to 21cm. Their fabric is medium hard and rather fine. Type I moulds are fewer in number and according to the excavator are associated with the production of higher quality sugar.

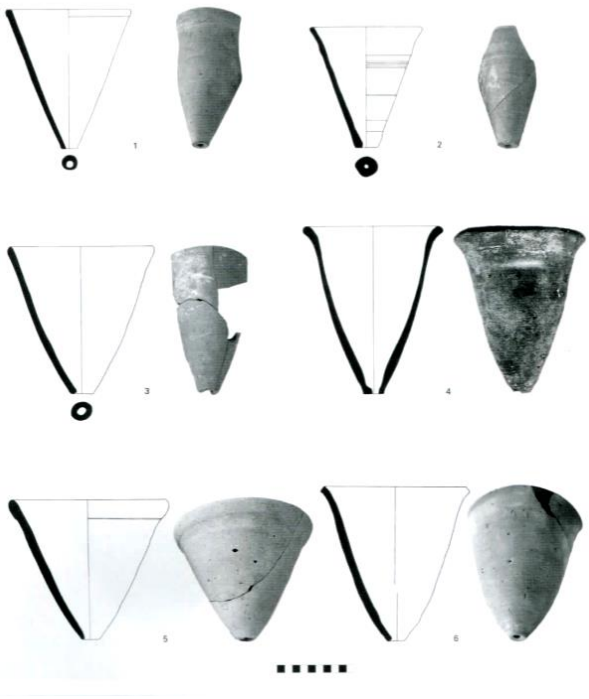

Figure 19: Moulds Type I (von Wartburg 2014,225)

Type II involves medium-sized moulds which are again divided in three subgroups (Fig. 20). Their fabric is coarser and more porous. Their shape ranges significantly, with Type IIA having a flattened globular shape, Type IIB is vertical funnel-shaped and Type IIC has straight sides from top to bottom.

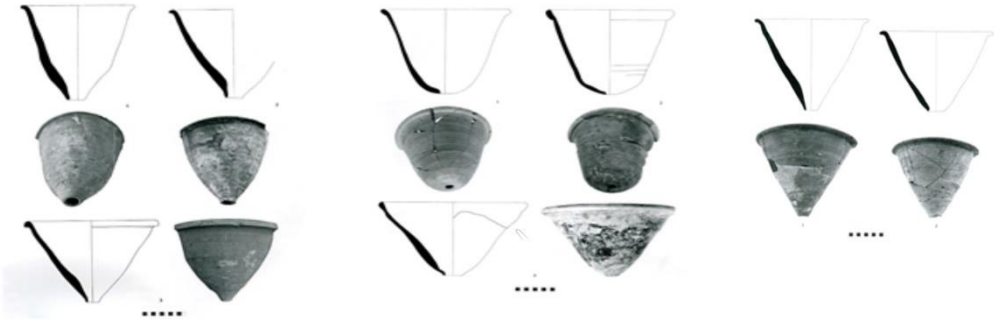

Figure 20: Moulds Type II (von Wartburg 2014,226-228)

Finally, Type III consists of taller moulds (Fig.21). This group is also divided into three groups, of which heights and diameter rims range, while their shape could be either conical or funnel-shaped. Their fabric is hard and wheel marks are visible in their interior.

Figure 21: Moulds Type III (von Wartburg 2014,229)

Molasses jars were also categorized into three groups, regarding their height and rim diameter (Fig.22). The fabric of all types is rather hard. Type I refers to the small jars, which are classified into three categories. Their shape varies from a cylindrical body to an ovoid-conical form. The medium sized jars belong to Type II and are also divided into three groups. Their shape ranges from ovoid to conical-ovoid shape. Unlike Type I, where the bottom is flat, Type II has a concave base. Finally, Type III consists of tall jars which are again categorized into three groups. Their shape varies from a conical to pear shape.

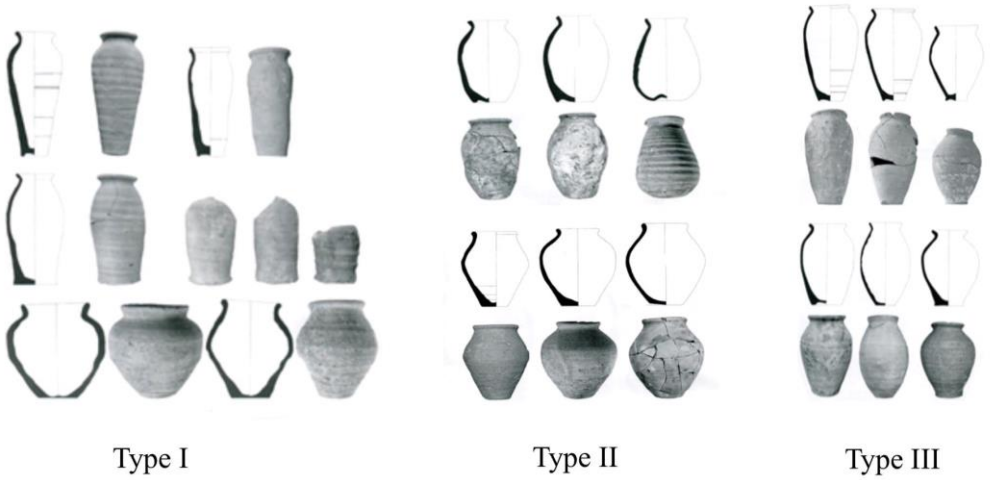


Figure 22: Molasses jars Type I, II, III (after von Wartburg 2014, 232-234,236-237)

Although there were significant difficulties in dating the vessels, the excavator proposed a chronological order (von Wartburg 2014, 237-239). In the TST complex the stratigraphy is not clear due to extensive farming and the reuse of the buildings, nevertheless there are undisturbed deposits dated in the later 13$^{th}$ and 14$^{th}$ centuries (von Wartburg 2014, 216-217). In these deposits, jars of Type IIA or IIB and moulds of Type IIA and IIB were found. Regarding Type IIA, these are proposed as 13$^{th}$ century because local 13$^{th}$ century glazed wares were also discovered in the sanctuary deposit. The molasses jars Type IIIA and IIIB were used during a later manufacturing period, when the production was already under Venetian influence. This was also verified by a comparative study of vessels from Episkopi-Serayia. In

this respect, Type II is dated from the 13th century and Type III from the 15th century (von Wartburg 2014,238). Unfortunately, the evidence to date the vessels of type I are insufficient; hence they are not characterized chronologically.

### *4.2 Sugar Pottery around the Mediterranean*

This present comparative research, involving selective archaeological sites, was conducted in order to acquire a deeper understanding of the pottery used in sugar production in the Mediterranean and especially in Cyprus. Specific sites which are the most well investigated and allow the completion of this research were selected. More specifically, I will now examine sugar pottery from the Jordan Valley, Palestine, Rhodes and Sicily (Fig.23). It is important to keep in mind that the Crusader-Ayyubid period in the Levant dates from 12th-13th centuries and the Mamluk period from 14th century. Moreover, the data extracted from Sicily are from the 13th and 15th centuries.


Figure 23: Map showing the compared sugar production centers around Mediterranean (from Google Earth).

The Levant is the first station in this examination. Small-scaled sugar production in the Levant area was already attested from the 7th century CE, while by the 10th century the production was generalized in the area of Tyre, Acre, Tripoli, Jordan

(Jones 2016, 33). When the Crusaders arrived, in the 12th century, sugar production flourished in this region. Hospitallers, Templars, Venetians and Genoese owned sugar plantations in the area around Acre. A century later, the Mamluk invasion led most of the Westerners to leave the area, while the Mamluks took over most of the sugar production. From the fifty sites associated with sugar production in Jordan and Palestine (Jones 2016, 36-39), the following five sites, Tawahin es-Sukkar (Safi), Khirbat Shaykh 'Isa, Tell abu Sarbut, Karak and Lower Horbat Manot, have been chosen in order to compare their pottery data with the ones of Cyprus.

Lower Horbat Manot is situated in West Galilee. The sugar production in the area had a long history from the 13th-17th centuries. Water mills, aqueducts, presses and boiling rooms operated at this site. Among the findings, sugar pottery was dominant. During the Crusader period (13th century), the Casale of Manuet was sold to the Hospitaller order. By that time, the sugar pots and the molasses jars were wheel-made and constructed of a reddish clay that contained limestone, quartz and shells (Stern 2015,91). The molasses jars compared to the moulds contained less temper (Jones 2016,65). The sugar vessels had thicker walls and wider folded rims. The shapes are different in the Mamluk period (14th- 15th centuries) when the moulds were heavier, larger with thicker walls, and folded rims. Similarly, there is a change in molasses jars as well, as they appear taller, ovoid-shaped and with folded rims (Jones 2016,68). Finally, the fabric from the Ottoman period seems to have followed a different recipe (Jones 2016,65).

Remnants of thirty-eight sites which are dated between the 11th and the 15th centuries were discovered in the Jordan valey (Politis 2010, 467), Tawahin es-Sukkar (Safi) and Khirbat Shaykh 'Isa**,** Tell abu Sarbut and Karak, among them.

Tawahin es-Sukkar (Safi) and Khirbat Shaykh 'Isa are situated in the Dead Sea. The pottery found at Safi and Khirbat Shaykh 'Isa were recently investigated in detail (Jones 2016). Petrographic analysis revealed that the sugar pots have calcareous composition with quartz sand and silt fabric, while their firing conditions varied (Jones 2016, 65). The shape of the sugar moulds varied from cone-shaped to bell-shaped. In one example at Safi there is a mould with two holes instead of one. The molasses jars are divided in two categories; the lighter ones with external

beveled rims (12th-13th centuries) and the heavy ones with thick walls and heavy rims belonging to a later period (14th century).

Tell abu Sarbut is located in the eastern Jordan valley. A research based on the construction methods used for the manufacture of the moulds was carried out by LaGro (LaGro 2009). Regarding the manufacturing techniques, it has been proposed that three ways of construction existed, all with smoothed interior. Vessels made with slabs of clay are attested in all the periods, while in the earlier phase they were wheel-thrown and in the later period they followed a straight built (LaGro 2009,93). The jars were made by a combination of slow-wheel and coils. Their classification is based on the typology of the rims. The moulds, however, had a conical shape which during the years changed to a more oblong one while the molasses jars had a flat or concave base (LaGro 2009, 71).

Karak is situated in East Jordan. The sugar moulds were well levigated and porous, but their firing varied. The moulds were conical with straight or slightly curved sides and made of coils (Milwright 2008,159). The molasses jars were constructed of a harder fabric than the moulds, which led Milwright to propose that this was in order to decrease the chances of vessels' breaking during transportation (Milwright 2008,160). However, another explanation could be that the jars were the supporters of the moulds and for that reason they needed to be stronger.

In the neighboring island of Rhodes at the site Zacharomylos, the moulds discovered by Michaelidou and Kollias are classified as Type II of the Cypriot classification system proposed by von Wartburg. The 300 pieces discovered in Rhodes have a height of 0.24-0.25 m., a base diameter of 0.09-0.10 m. and a rim diameter of 0.28-0.30 m. (Kollias and Michaelidou 1997, 45).

Finally, at Palermo in Sicily a sugar production center operated for many decades. According to the examination of Tullio, the moulds were 24.5 cm. in height and 20.8 cm. in diameter, while the molasses jars were cylindrical with a height of 21cm. and a 15.7 cm. diameter. During the15th century, the sugar moulds were essentially of two types, the large ones 50 cm. in height and with a diameter of 26-28cm. The small ones were 37 cm. in height with a 19 cm. diameter. The jars were again of two types, the large ones 31-35 cm. in height and a diameter of 10 cm. The small jars were 24-27 cm. in height and 10 cm. in diameter (Falsone 1974, 109).

### 4.3. Concluding Remarks

From the above examination of the sites in the Mediterranean some remarks regarding the manufacturing techniques, raw materials, shape, use and the actual production centers could be made. From the results I plan to attempt to answer what the technological choices of the potters were and whether a 'package' that came from the East existed or not.

Regarding the manufacturing techniques, in Cyprus both moulds and jars were wheel-made. However, in the Near East area, there is a variation in these constructions (LaGro 2009). Yet, although the construction technique is different, the finishing technique appears to be the same. As already mentioned, the interior was smooth so that the extracting of the sugar loaf from the vessel was made easier. Milwright proposed that a bag that contained a fixed quantity of sand was placed inside the evolving mould in order to standardize its shape (Milwright 2008,160). Ethnographic research by Régaldo-Saint-Blancard on the manufacture of sugar moulds and jars of the 19$^{th}$ century at Sadirac, a 'sugar pottery' production center which has been in use from the 13$^{th}$ century in France, has helped us to reconstruct the forming stage (Régaldo-Saint-Blancard 1986).

It has been observed that raw materials used around the Mediterranean were identical. The potters preferred to use calcareous clays. The use of this kind of clay is not only a matter of choice. Calcite was used in sugar in order to take out the impurities. We should not forget that sugar is an edible product and it was necessary to have it as clean as possible. Calcium was used in sugar as an absorbent of impurities contained in the sugar syrup (Burchard and Emley 1913,1589-1590).

Considering the shape of the moulds, in one example at Safi there was a mould with two holes instead of one. This unique example from this area was probably an experiment which was not widely used. Looking at the drawings of the shapes, it has been observed that Type II according to von Wartburg existed in all the sites presented (Table 2). This shows us that there is a repertoire that is followed. This type is attested to the Levant during the 13$^{th}$-14$^{th}$ centuries, when Type II in Cyprus is also dated. A possible interpretation about the extensive use of this specific type might be associated with the Crusaders who, as owners of all the sugar production sites, established a repertoire that was used by everyone. Finally, it has been

observed that the shape of the moulds became gradually longer and larger as proved by the pottery for sugar production from 15th century in both Sicily and Cyprus. It has been proposed that this change occurred *"in response largely to improvements in the technology of sugar production."* (Jones 2016, 81). However, another explanation could be that in the later years there was a demand for mass production of sugar.

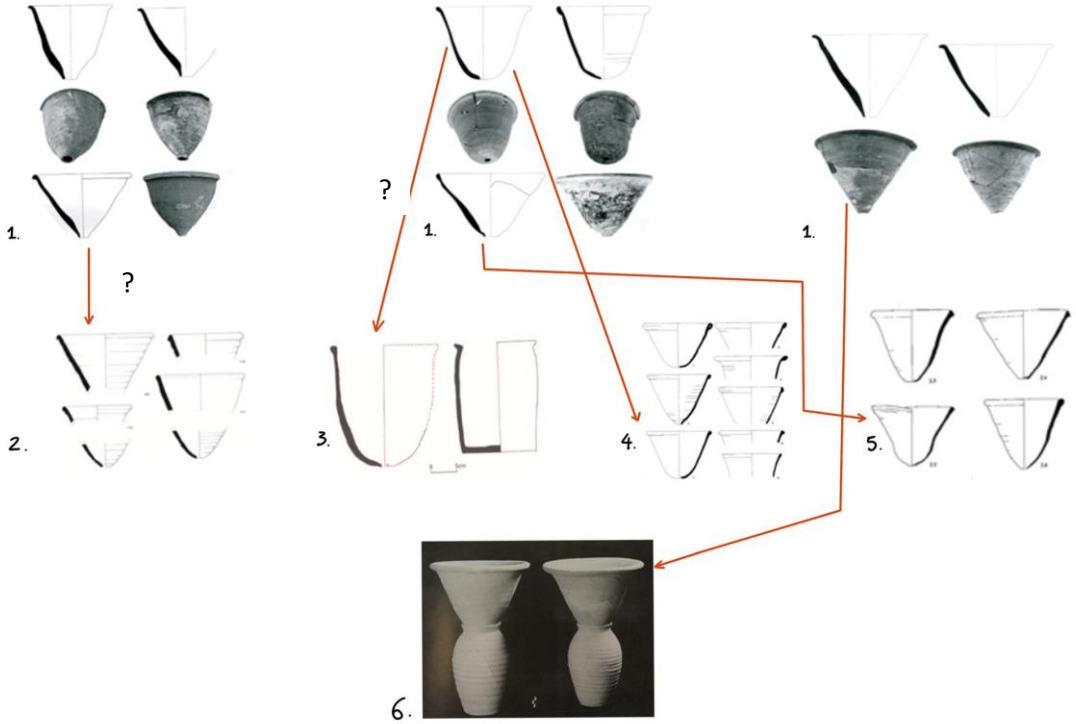


Table 2: Similarities between the moulds Type II from Cyprus and from sites around the Mediterranean. 1. Cyprus, (von Wartburg 2004,226-228); 2. Safi (Jones 2016, 69); 3. Sicily (Tullio 1997,474); 4. Lower Harbot Matot(Stern 2001,285); 5. Tell abu Sarbut (LaGro 2009,76); 6. Zacharomylos (Kollias and Michaelidou 2004,13)

The shape of the moulds is usually associated with the quality of sugar produced. Francesco Pegolotti, in 1330s rated sugar powder from Rhodes as being as good as that from Cyprus (Kollias and Michaelidou 2004,15). However, the archaeological remains do not agree with this suggestion. Type II moulds resulted in a lower quality of sugar (*musciatto*), while the high-quality pulverized sugar was collected

from smaller vessels. Yet, the basic factor to acquire sugar of high quality is related to the number of times sugar was boiled.

Regarding the molasses jars, there is a significant variation in shapes. The excavator identified similarities of jar Type IIC with molasses jars from the refineries of Lower Horbat Manot, Karak and Safi (von Wartburg 2014, 235). She stresses, however, that this very type is not common in Cyprus. Were these vessels imported or were they made by potters coming from the Levant? This is a question which needs further analysis to be answered.

Nevertheless, the numerous shapes of molasses jars could be explained by the fact that jars were widely used for various purposes apart from the sugar industry**.** Another interpretation is that as the jars functioned as supporters of the moulds they had various shapes in order to fit the moulds.[12]

The use of the jars may also have varied. In some areas of the Mediterranean, another vessel, a basin is added in the sugar production process (Jones 2016, 62).[13] This extra vessel was considered to be used in order to transfer the syrup from the cauldrons to the vessels. Extra vessels were not found in Cyprus. However, in Kolossi basins full of ceramics were found. These probably indicate that the ceramics were reused. This is interesting if we think that the sugar refineries were run by very wealthy people. Another possible scenario that was proposed for the transfer of syrup to the cauldrons was based on an 18$^{th}$ century illustration, where a spout-shaped vessel is depicted. This might have been used for the above purpose (Jones 2016,80). However, such a finding does not occur in any site in Cyprus or around the Mediterranean. Another suggestion could be that large ladles might have been used. It is known that during the boiling stage this kind of utensil was used in order to stir the syrup. This stage is also depicted in the figure below (Fig.24). Nevertheless, this kind of finding does not occur in any of the sites, but this could be explained by the common practice of melting metals to sell.

[12] This idea has been challenged by LaGro, who argues that the vessels were not attached to each other (LaGro 2009, 73).

[13] This type of basin is also found in Iran at the site Shaur-Susa (Jones 2016,63).

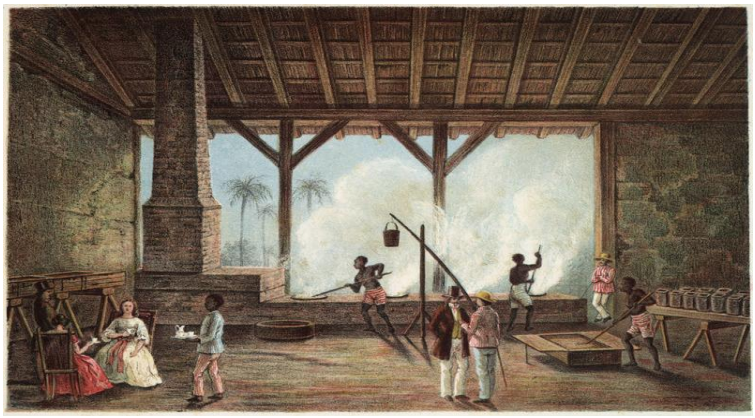

Figure 24: Mialhe Frédéric, “View of a Sugar Boiling house”. Plate XXVI in Album pintoresco de la isla de Cuba, 1851
http://www.slaveryimages.org/s/slaveryimages/item/2165, accessed on 2 July 2020.

Overall, this pottery comparison shows that there are multiple similarities and differences between the vessels originating in different sites. The fact that Type II is commonly found across the Mediterranean could indicate that this repertoire is followed in the 13$^{th}$-14$^{th}$ centuries. However, the construction of the moulds and jars was different, and this proves that artisans were acting locally, but this would need confirmation.

## *Chapter 5*

## *The human force behind the Sugar Production*

This chapter attempts to identify those behind the sugar production. The aim is to identify the relationships between the owners and the status of people who worked in the sugar industry.

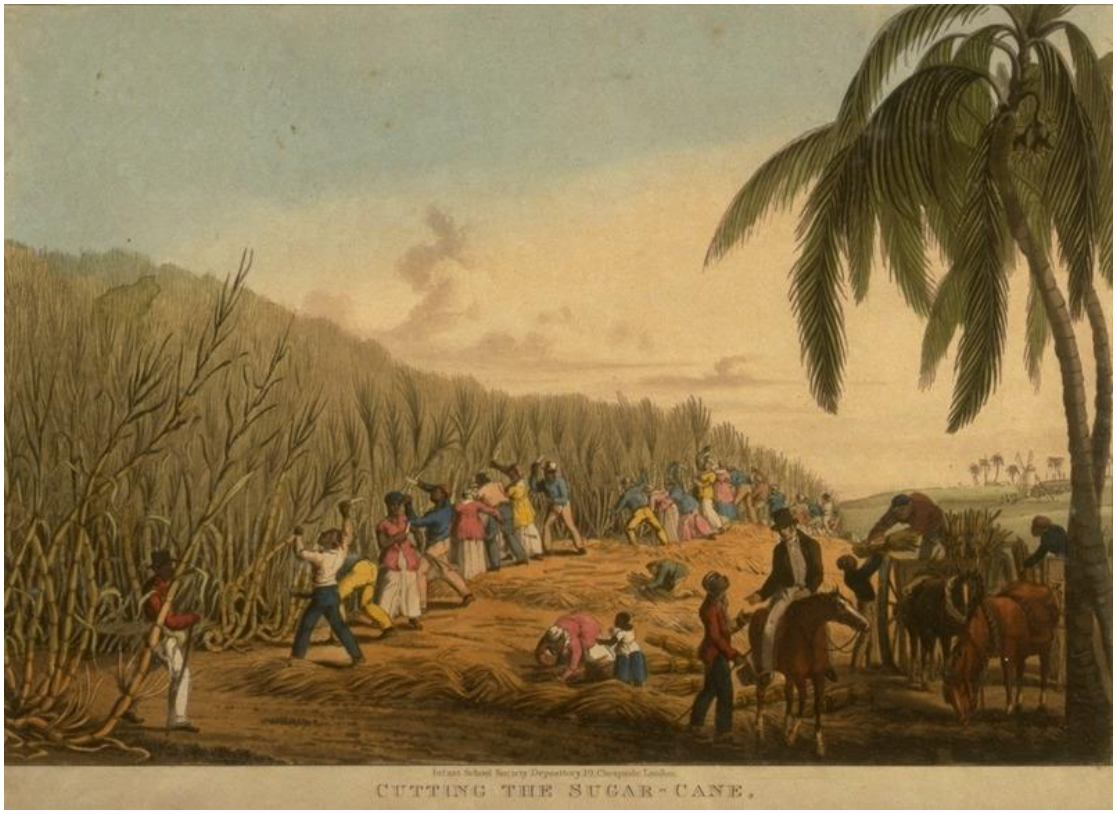


Figure 25: Clark, William. "Cutting the Sugar Cane" Antigua, West Indies, 1823

http://www.slaveryimages.org/s/slaveryimages/item/1113 , accessed on 2 July 2020.

### *5.1. Ownership*

The Cypriot land during the medieval period was mainly under the control of the non-local nobility and the knights (Coureas 2017, 369). The establishment of sugar cane production in Cyprus began with the construction of the sugar complex at Kouklia- Stavros. The Lusignan family, during the 13th century, some years after their dominance in the island, constructed the sugar production complex at Kouklia. The first king of Cyprus, Guy de Lusignan (1150-1194) originating from Poitou of

France, before arriving to the island was the king of the Crusader state of Jerusalem (1186-1192). The Franks showed an interest and had already been involved in sugar plantations in the Levant (Bronstein et.al 2019,321). Consequently, they were familiar with sugar production before arriving on the island.

The second sugar mill at Kolossi belonged to the Order of Saint John. The Knights of Saint John, known as Hospitallers were a military and religious order created in the early 11$^{th}$ century in Jerusalem. When Jerusalem was occupied by the Muslims in 1187, the headquarters of the Order moved to Acre, where they owned sugar plantations (Stern 2015,88). When Amaury (1155-1205) was crowned king of Cyprus and Jerusalem in 1198, Pope Innocent III (1161-1216) ordered the military commanders of Cyprus, and especially those of the Knights of Saint John, to take care of the security of the island and in return they were granted with some privileges on the island. Some of these privileges included Kolossi, which was transformed to the seat of the battalion, in 1302. Along with this administrative center, Hospitallers established a sugar production complex in the area.

At the beginning, the policy implemented by the Franks was favorable towards the Hospitallers with many benefits, involving exemption from taxation. However, later in the 1290s, Henry II (1270-1324) forced their servants to pay poll tax (Edbury 1991, 112). In 1309, the Hospitallers moved their seat to Rhodes, however the sugar production in Cyprus was not abandoned, but was still functioning for at least two more centuries.

The Hospitallers were not the only ones who gained benefits from the Frankish kings. The Franks and the Venetians had a relationship based on mutual exchange of favors for many centuries. The occasions when Frankish rule granted economic advantages to the Venetians are numerous. On June 1306, Amaury (1272-1310) signed an agreement with the Venetians providing them with benefits. His aim was to have them by his side in order to have more allies to legitimize his occupation of the royal throne. Later, in 1328, Hugo IV (1295-1359) signed an agreement with Venice that confirmed the trade privileges given to the Venetians in 1306 (Edbury 1991,154, Aristeidou 1990,17).

In the 14th century, King Peter I of Cyprus (1328-1369) sought to raise large sums of money which were needed to finance the Crusaders, who were preparing a new

attack against the Turks for the liberation of the Holy Land. In order to receive economic aid, he granted financial alleviations to Italian merchants. In 1366, the Cornaro family granted Peter a loan with a very high interest rate and for that reason, Peter granted the Cornaro family the right to exploit the salt pans and to control the feuds at Episkopi, where Federico Cornaro created the sugar cane plantations (Aristeidou 1990 vol I, xiii). Their relationship with sugar plantations was known from the 12th century, when they established them next to the Frankish ones at Acre. The defeat by the Mamluks exacerbated the state's finances and forced Janus (1398-1432) to arrange a loan with the Venetians, to whom he ceded sugar or other sources of income as a pledge, thus boosting Venetian trade in Cyprus. Some years later, the Venetians occupied the island and their rule lasted about 80 years (1489-1571).

During the Venetian domination, there were many catastrophes and raids by locusts, which resulted in severe damage to the island's agricultural production (Aristeidou 1990,101-102). However, such disasters were not the only ones that destroyed the plantations. Disputes between the owners were not absent. As mentioned earlier, the sugar plantations of Kolossi and Episkopi were in close proximity and the two industries had to share the same water source, the river Kouris. The Cornaro family often had issues with the Order of Saint John. In 1468, the redirection of the water supply by the King's officials, caused inevitable destruction of the sugar canes resulting in a remarkable loss of revenue amounting to 10,000 ducats. Despite their protests the Venetians were never compensated (Hill 2010, 627-628).

Regarding the exportation of sugar, one document informs us that in 1301 a Genoese merchant sold one box of Cypriot sugar to Pisa (Phillips 2018, 674), while in the 14th century, sugar was also exported to Constantinople (Coureas 2008, 132-133). From 1440 onwards, the growing demand for sugar in the West stimulated the Venetians to develop a great economic interest in its trade (Jacoby 2009, 64). By the 15th century, the Venetians were the monarchs of the island, and this is also reflected in increased sugar production. In 1461, all sugar produced at Kouklia was contracted to the Martini Brothers, Giovanni and Girolamo, merchants from Venice, while from the 1440s and 1450s they secured for themselves the good quality "*venditio pulverum zucari*" of Kolossi. From the sugar they exported, they kept 12 quintals for themselves (Borchardt 2008, 164). Sugar from Episkopi was

also of great importance, as it is testified by a document dated on 1515, when Zuan de Nores went to Paphos and loaded 22 quintals of powder sugar at the price of 500 ducats (Aristeidou 1990,121).

However, the domination of the Venetians on the island was not favorable to the locals. During the period of Venetian rule in Cyprus, two rebellions were reported. The first took place in 1562 and was led by the Cretan Iakovos Diasorinos but was unsuccessful. The second successful one occurred in 1565, when the main demand was for food as a great famine had plagued the island due to failed harvest (Aristeidou 1990,104). Jacques le Saige in 1518, maintains that the Cypriots were heavily taxed, and had trade connections only with Venice (Cobham 1908, 57). The chronicler Kyprianos informs us that a great part of the population was dissatisfied with the elite and wished a change of ruling power. Being in a state of slavery, they were not only for years subdued by the elites of the island, but they also had to pay the military to guard their sea. When Venetians had gained power, they left the elite-tyranny intact:

*"Ἀνάμεσα στούς Κυπρίους ἦταν ἕνα μέρος ἀρκετόν λαοῦ πολλά δυσαρεστημένον ὅπου ἐπιθύμει ἐναλλαγήν τῆς ἐξουσίας. Αὐτό ἦτον ἕνα πλῆθος, τό ὁποῖον παλαιόθεν εἶχον ὑποτάξει οἱ εὐγενεῖς τῆς Κύπρου, ὑποχρεωμένον εἰς σκλαβίαν, καί μάλιστα νά πληρώνη καί νά κυβερνᾶ τήν διωρισμένην καβαλαρίαν διά φύλαξιν τῶν αἰγιαλῶν. Οἱ Βενετζιάνοι γενόμενοι κύριοι τῆς νήσου ἄφισαν ἀχαλίνωτον τήν τυραννίαν τῶν ἀρχόντων..."* (Αρχιμανδρίτης Κυπριανός 1933, 404-405).

*"Among the Cypriots, there was a large number of people who were very dissatisfied and wanted a change of power. This part of the population, which in the past was under the elite of Cyprus, was forced to slavery and moreover had to pay the appointed cavalry to guard their coast. When the Venetians became masters of the island, they retained the tyranny of the local masters unbridled..."* (Αρχιμανδρίτης Κυπριανός 1933, 404-405).

By the 16th century the refineries started to decline. An inscription found on the south side of the Kolossi refinery shows that the building was renovated in 1591 under the rule of Murad Pasham (1535-1611). The ones at Episkopi and Kouklia stopped to operate around 1600. At the same time, sugar refineries in Bologna and

Venice were built (Galloway 1977, 186-192). This may indicate that the sugar production centers were transferred.

Overall, the Lusignans have granted extensive privileges first to Hospitallers and then to the Venetians. Their purpose was to have many supporters, in order to be more powerful. Due to the close proximity of the sugar plantations, conflicts were not absent. During the Venetian rule, sugar production was a Venetian monopoly. Their strict policy, however, triggered the reaction of the Cypriot population. Finally, during the Ottoman occupation, sugar production was under Ottoman control and eventually declined.

### *5.2 Workforce*

The human landscape of the Mediterranean is composed of heterogeneous, polymorphous and converging worlds. Devaney describes Cyprus as a 'frontier zone' or meeting point between different civilizations (Devaney 2013, 304). In order to reconstruct the workforce used in sugar production, and to assess the argument that slaves were the working force at sugar plantations at Cyprus, it is essential to review the population and the social stratification of Cyprus, during the Frankish and Venetian rule.

The vast majority of the Cypriot population were Greek Orthodox and lived in both urban and rural areas (Nicolaou-Konnari 2005, 14). Small communities of Armenians, Copts and Jews also lived in the cities (Nicolaou-Konnari 2005, 15). The Lusignans were worried about the demographic superiority of the Greeks and favored the settlement of Latins. Most of the first settlers were French knights and the elite, who had lost their possessions and incomes in the Latin states of Syria and Palestine, while others were newcomers from Western Europe. In order to balance the demographic difference with the indigenous population and attract new settlers, generous land concessions, social and economic privileges were given to them. Riley-Smith states that Guy repopulated the island "with colonists from the Latin East, creating about three hundred feuds for knights" (Riley-Smith 1967, 10). In addition, after the fall of Acre, refugees from Syria, Antioch and Tripoli arrived at the island. A big part of the above-mentioned groups were farmers and artisans. It has been suggested that this wave of immigration brought with it further

technological knowledge of sugar cane cultivation, which was established on the island (Jacoby 2009, 74; Coureas 2013, 217).

The Lusignans implemented a new social system aiming at regulating relations between the two main ethnic groups. On their settlement in Cyprus, the Franks did not introduce a system of colonial exploitation. Instead they implemented a local administrative and institutional system. Consequently, these were based on cooperation with the indigenous Greek population and aimed at ensuring the greatest economic and social advantages for the ruling Latin class, but also at achieving conditions of peaceful coexistence with the lower social strata (Nicolaou-Konnari 2005, 21,59).

The deafening absence of national or social uprisings against the Frankish rulers and the compromising attitude of the Greeks might be explained by preceding events, namely the harsh rule of Isaac Doukas Komnenos (1184-1191) the rapid conquest of Richard I (1157-1199) the two failed uprisings against the English garrison (1191) and the Templars (1192). In the context of the new socio-economic reality and thanks to its cooperation with the new regime, a new class of Greek elites gradually emerged (Nicolaou-Konnari 2005, 59).

The institutions introduced were feudal in nature and of Frankish origin. The Frankish settlers brought with them laws on land ownership, military obligations, and the inheritance of feuds. The legal system of the Latin kingdom of Jerusalem had been introduced to the island, as described in the Assizes, an unofficial collection of treatises based on the proceedings and decisions of the courts (Hill 2010, 6). Since the Greek elites were also recorded amongst the ruling class, the Assizes of this court were translated into the Cypriot Greek dialect between the end of the 13th and the middle of the 14th century (Nicolaou-Konnari 2005, 22). At the same time, acting prudently, the Lusignans retained many of the pre-existing Byzantine institutions and allowed the staff of the public service to include native Greeks.

The Venetian government continued the previous Lusignan administration in order to maintain the balance between the citizens (Nicolaou-Konnari 2018, 51-52). In 1490 the Venetian government took an oath to retain the laws, institutions, customs

and privileges of all social groups on the island (Mas Latrie 1882, 528). However, as already mentioned a period of conflict did exist.

Regarding the social structure, the ruling class was composed of the *nobili/ feudati*, the upper class, which was a minority mostly consisting of Franks, Venetians and a few Greeks. In 1478, the Venetian Republic issued a decree granting arable land with lucrative annual income to a hundred families of Venetian nobility who would settle on the island (Hill 2010, 729) and, hence becoming mainly landowners. They were exempt from any kind of compulsory labor offer (*angaria*) and their only obligation was to join the army (Aristeidou 1990, 89,90).

Educated and multilingual Greeks also belonged to the nobility. From the beginning of Frankish rule, they started their careers as officials in the royal administration, as notaries and merchants and, after acquiring the necessary socio-economic means, they ascended to the Frankish aristocracy (Nicoalou-Konnari 2018,58**)**. They acted as an intermediate class between the Latin nobles and the lower Greek strata. They significantly influenced the process of cultural exchanges between the two ethnic groups.

In the countryside, the Frankish regime maintained the Byzantine social stratification. The peasants consisted of the *parici* and the *francomati*. *Parici* were financially and personally dependent on their master. According to Boustronios *"il Parico è vocabolo greco, tratto da "παρὰ τοῦ οἴκου", che vuol dire huomo obligato star appresso la casa, che non si può partir da quella casa, overo casale, senza licentia de patron di quel casale."* (Boustronios 1886,461).

*"Parico is a Greek word, derived from "παρὰ τοῦ οἴκου", which denotes a man obliged to stay within the house, that one cannot leave from this house (οἶκος) or rather the farm premises, without the permission of the patron of this property*." (Boustronios 1886.461).

The *parici* were obliged to work for the landlord to whom the land belonged, to perform labor (*corvée / angaria*) work twice per week, to pay a head-tax which was the one-third of their income. In return they received protection and justice from their master. The Lusignan used the word *servus* / *serf de la glèbe*, in order to name them, while the Venetians used the word *parica* (Nicolaou-Konnari 2018, 68).

*Francomati* were free and performed public services. They had to pay the tithe tax and were obliged to provide free service for 10 days a year or to redeem their labor at the amount of 5 Byzantines (Aristeidou 1990, 92).

After this presentation of the social structure of medieval Cyprus, I will proceed to the suggestions proposed, concerning the status of people who worked in sugar production. Galloway, exploring the sugar plantation in the Mediterranean writes that "*the link between sugar production and slavery, which was to last until the 19th century, became firmly forged in Crete, Cyprus and Morocco.*" The slaves that were put to work on the sugar estates of Cyprus were "*Greeks, Bulgarians, Turkish prisoners of war, and Tartars brought from the shores of the Black Sea."* (Galloway 1977, 190). Arbel and Dincer have also studied and supported the existence of slavery in the Mediterranean (Arbel 2000; Dincer 2016). Greenfield supports that during the $10^{th}$-$15^{th}$ centuries, there was no use of slaves on the plantations. On the contrary, they used free peasants and the crops were obtained by those who had feudal rights in the plantations (Greenfield 1979, 89). According to Ouerfelli, after the fall of Acre, artisans immigrated to Cyprus and began cultivating sugar cane based on their previous sugar production experience in Palestine (Ouerfelli 2008, 102–121). Moreover, in one of his studies he challenges the existence of slaves on the island and he supports that slaves lived and worked for sugar production only during the $15^{th}$ century, when there was a shortage of labor, due to the Black Death (Ouerfelli 2016,49-53). Finally, Tsugitaka, who examined sugar production in the Islamic societies, challenges Mintz's view that slavery exists in the Islamic Levant (Tsugitaka 2015, 26). She examines the Arabic texts and concludes that there are no documents which refer to slaves used for this purpose.

In order to assess the above views, it is necessary to examine the written sources. The number of people who worked in the sugar production was immense. According to Pietro Casola at Episkopi in 1494:

*"There were not less than four hundred persons there, all employed – some in one way, some in another. It was interesting too, to see such a number of utensils; it was like another world to me. There were cauldrons of such a size that if I described them no one would believe me. One of the factors of the aforesaid Don Federico*

*told me that every man was paid every Saturday. The said factor was an Italian, but he knew Greek"* (Casola 1904, 216).

The huge amount of laborers needed in the sugar industry is understandable, considering the wide variety of jobs that are involved: the construction and maintenance of the buildings; the mills; the pottery; the irrigation system; the cultivation of the sugar cane; the cutting of it; the transfer of the harvested cane to the factories; the crushing of the canes; the boiling of the sugar; the final preparation of the product and its transfer to the ports.

Casola's testimony maintains that those who worked in sugar production at Episkopi were paid every Saturday (Casola 1904, 216). This could mean that *francomatti* or *parici* were employed on the plantations. As we have already mentioned the peasants (*parici*) had certain labor obligations among their responsibilities. Nicolaou-Konnari confirms that one of their obligations was to work in the sugar plantations, which was considered as *angaria,* but they had the right to be exempted of the 13days of this if they paid the redemption fee (Nicolaou-Konnari 2018,79).

*Angaria* (ἀγγαρεία) was a word which gained multiple meanings throughout the years. The noun derives from the Persian word *agar*, which means the equestrian postman of the Persian state (Smith 1875,94). In Roman times, it was connected with the construction of public services.[14] In Suidas, *angaria* is defined as compulsory forced service: "*ἀγγαρείαν ἀνάγκην ἀκούσιον λέγομεν καὶ ἐκ βίας γινομένην ὑπηρεσίαν.*" (s.v. ἀγγαρεία). In French, the word *angaria/ corvée* meant the right the lord had by law to impose compulsory labor without monetary compensation.[15] The implementation of *corvée* was valid on all possessions under Venetian occupation. However, heavy taxes combined with forced labor created resentment**.** For this reason, *angaria* was connected with the slavery. Aristeidou describing the obligations of *parica*, *angaria* among them, supports that *parici* were

[14] Merriam-Webster s.v. corvée.
[15] Ibidem.

like slaves as they worked excessive hours and belonged to their master (Aristeidou 1990,92).

Taking a closer look at the etymology of the Greek word (*δουλοπάροικος*) used for *parici*, we notice that the first component of this word is *δοῦλος*, which means slave and the second one is *πάροικος*, which means the one who lives next to you. Yet, these individuals, as explained earlier, had both obligations and rights. In contrast slaves, who were used in sugar cultivations in the Americas (Fig.25), were considered as property, without any rights. Therefore, *parici* connected with the sugar plantations were not exactly slaves.

Nevertheless, this does not mean that slaves were completely absent from the sugar cultivations. The famine of 1315 and the epidemic plague of 1350 decreased the population not only in Cyprus, but around the world. By the 14$^{th}$ century, a large influx of slaves is attested to the island, as there was a shortage of labor. Makheras, a chronicler of the period mentions a Saracen baptized slave, named George of Tamathiani, who was a sugar-boiler, just before the Mamluk invasion of 1426 (Makheras 1882, 380).

In summary, the written sources clearly confirm that a substantial number of laborers toiled on the sugar plantations. This vast workforce was needed for the building of the infrastructure, the cultivations, the transportation and the refining processes which also demanded a wide range of skills. *Parici*, *francomati* and slaves were all part of the sugar production process.

## *Chapter 6*

## *Capitalism and Globalization*

The purpose of this chapter is to give a brief overview of the archaeological results related to sugar production in Cyprus, presented in this thesis, in a socio-economic context. Hence, I will endeavor to contribute to the topics of capitalism and globalization, two widely discussed concepts today.

Figure 26: Abraham Cresques, "Catalan Atlas" depicting the Eastern Mediterranean 1387. Paris, Bibliothèque Nationale

### *6.1 Capitalism*

The genesis of capitalism is usually sought in pre-existing systems and embryonic industrial economies (Lafrance and Post 2016, 2). According to Matthew Johnson, historical archaeology explores the transition from the medieval to the modern world, in other words, the "origins of capitalism", the "feudal/capital transition" and "industrialization" (Johnson 2010,191-192). A plethora of theories regarding the starting point of the capitalistic system have been proposed over the years. Capitalism is seen as the outcome of feudalism (Wood 2002, 73), of industrial revolution (Kaldor 1977,193) or of colonization (Blaut 1989, 291) to name but a few theories.

The above suggestion followed a Eurocentric approach. Braudel, however, was one of the earliest scholars to explore forms of capitalism in non-European states (Braudel 1984). Either western or eastern in origin, the transition to capitalism should not be perceived, as Sweezy convincingly notes, as "*a process in which the two systems directly confront each other and fight it out for supremacy*" (Sweezy 1950, 150).

Capitalism is often associated with the interpretation of Karl Marx according to which, money is transformed into capital, peasants into laborers and landlords into merchants (Marx 1887). The "commercialization model" which considers the market as the cornerstone of economic institutions, has been a long-established narrative of classical political economists (Wood 2002, 11–12). Adam Smith, a pioneer economist of the 18$^{th}$ century, suggested that market growth strengthened economic progress and that capital accumulation is linked with financially and politically powerful people (Smith 2003).

In the previous chapter, where the social stratification is described, it is stressed that the political system in medieval Cyprus was based on feudalism. Yet, some of the essential characteristics of capitalism such as, capital accumulation, private ownership, wage labor, profit-oriented, antagonistic and open markets are already evident in medieval sugar production in Cyprus.

It is only since the work of Mintz, in "Sweetness and Power", that capitalism associated with sugar production, gained notable attention. More specifically, Mintz argues that "*if it is not "capitalism", it was still an important step towards*

*capitalism*" (Mintz 1985,55). This statement has been reconsidered by contemporary scholars, who have explored the relationship of sugar and capitalism (Armstrong 2019; Simpson 2019). In addition, Mintz describes the sugar plantations as an "*early agro-industrial*" system, where the "*agricultural processing is under one authority*" (Mintz 1985, 51).

Douglas Armstrong who recently examined the sugar plantations in Barbados in the 17th century, strongly supports the formation and existence of capitalism during this period. According to him, the social and economic change on this island favored the emergence of large sugar plantations and of capitalism. He argues that the appearance of "*agro-industrial*" plantations are associated with the emergence of capitalism (Armstrong 2019, 470).

Another study, which associated sugar production with a capitalistic system, attempted to link capital accumulation with Islamic sugar production (Simpson 2019). The colonial perspective of capitalism supported by western archaeologists is challenged by Simpson who attempts to approach capitalism from a non-Eurocentric angle. He proposes that Islamic merchant culture and interconnections of Asian and African trade played a significant role in the evolution of capitalism.

In an attempt to explore sugar production in Cyprus through a capitalistic lens, I will endeavor to interpret the archaeological findings in this thesis incorporating them into a political and economic frame. Sugar production was established in Cyprus in 13th century and lasted till 16th century. Prior to being one of the most broadly produced and consumed commodities, sugar was a product of demand amongst the upper classes. Franks, Hospitallers and Venetians were the owners of the majority of the plantations. Monopoly of the land and investment capital are central strands for the narrative of capitalism. As already stressed the owners had copious savings, essential for the construction of the irrigation system, technologies and infrastructures.

In Chapter 3, it was clear that the owners of the sugar industries were experimenting with the technology used in sugar production. Their central motive was to acquire more profit. Firstly, the Franks introduced the vertical water mill in sugar production because it was considered more powerful and efficient. However, due to practical reasons this was soon abandoned. The horizontal-water mill was a mill

originating from the East and known for its efficiency in sugar production, also being less expensive to run and maintain. It was used in all the sites in Cyprus and it was never abandoned. Its broad use in the East during the same period indicates a powerful and profitable technology. The last machinery, probably introduced by the Venetians, were the presses, which were attested in all the three production sites of Cyprus.

Archaeological records confirm that technologies originating from the east and west co-existed in sugar production in Cyprus. The constant and enduring process of experimenting and implementing new technologies indicates that sugar was a profitable product and that the owners desired to invest in order to produce better quality sugar and hence, to amass more profit. The accumulation of capital, the profit-orienting process, the competitive market are critical elements of a capitalistic system. However, as proposed in the previous chapter, the labor used was diverse and based on feudalism. The economic forces of this period follow not a static, but a dynamic process with capitalistic features. Yet, sugar production in Cyprus cannot be characterized as capitalistic *per se* or non- capitalistic, but as a hybrid.

The hybridization and interconnections associated with long distances, as demonstrated in sugar production, leads us to the concept of globalization.

### *6.2 Globalization*

Along with capitalism, globalization is another avidly debated topic (O'Rourke and Williamson 2002; McNeil 2008; Jennings 2014; Hodos 2017; Sachs 2020). It is a popular term, which has multiple meanings and is used in various contexts: cultural, technological, environmental, economic, political and social. Some of its characteristics are interconnectivity, cross-cultural communication, transfer of technologies, free movement of products and people and diffusion of practices and ideas.

One might wonder what globalization, a concept that refers to an international, worldwide phenomenon frequently associated with the modern world, has to do with this research which explores medieval archaeological sites in the Mediterranean. According to Hodos globalization "*is uneven and asymmetric in pace, scope, and impact*" (Hodos 2017,4) and as such has a complex connectivity, with varying speed and size differing over geographies and time.

Three different views, regarding the origins of globalization have been recently proposed. The first considers it as a new phenomenon, that dates from five centuries ago (O'Rourke and Williamson 2002, 47). The second perceives it, as a gradual process (McNeil 2008,9), and the third one, as a process which appeared multiple times in the past (Wolf 1997,24-73; Jennings 2014; Sachs 2020).

Jennings, a proponent of the last view, attempts in his work to knock down the "*Great Wall*" that disconnects the modern world from its history (Jennings 2014,19). Indeed, one of the aims of the study of history and archaeology is to understand the present through the past. However, if we wish to avoid anachronisms, we should bear in mind that each society and era are unique.

Following Jennings' view and considering the archaeological findings from sugar production in the Mediterranean, I will attempt to assess whether a process of globalization was occurring during the $13^{th}$-$16^{th}$ centuries. In order to identify whether globalization existed or not, it is firstly essential to define this process. For the purpose of this thesis, I will adopt Jennings' theory, who supports that there are certain criteria which can be used to trace globalization in the past. The criteria proposed are "(*a) a surge in long-distance connection that (b) caused the specific array of cultural changes associated with the creation of a global culture*."

(Jennings 2014,21). Jennings proposed several trends to comprehend "*global culture*": the sense that the world is gradually becoming smaller; the feeling that places are disconnected from the local; the adoption of a common *modus operandi*; the differentiation between the various global networks around the world; the adoption and rejection of ideas and goods along with their fusion with local practices and, finally, interdependence.

Having presented these criteria, I will examine whether they can be applied to sugar production in medieval Cyprus. In the previous chapters, an attempt was made to place sugar production in Cyprus in a broader perspective. Cyprus was examined in comparison with contemporary sugar production complexes around the Mediterranean. Sugar was and remains a worldwide exported product. However, what is attempted here is not to investigate the scale to which the product was sold and produced, but rather the scale to which the technologies used in its production are connected.

Examining the technology used in the milling sector and the technology of the pottery, we conclude that there are significant similarities between the archaeological sites. More specifically, we traced similarities in the horizontal mills, which existed both in the Levant and in Cyprus. Moreover, regarding the pottery, Type II moulds were also detected in both areas. Nevertheless, there were milling devices that were introduced to specific places by the Crusaders and there were also differing types of ceramics such as, Type I and III moulds and jars that were unique in Cyprus. Therefore, considering Jenning's criteria of globalization we can observe that there is: a long-distance network (across the Mediterranean); an adoption of technology (horizontal mill) and a creation of a common utensil (moulds Type II). Yet, at the same time we can point to small-scale differentiations of technologies (vertical-water mill, presses, Types I and III moulds and molasses jars).

Given that there are certain steps to be followed in the sugar making procedure, this cannot but be globally adopted. Indeed, in all the sites in Cyprus and across the Mediterranean there are specific stages in sugar production that are commonly followed. However, not only the production stages are the same, but the technologies used as well. We have supported that the horizontal-water mill and the

wide use of Type II sugar moulds, indicate close connection of peoples in the Mediterranean. In addition to these similarities there are also local transformations such as various types and methods of construction used in ceramic production and in experimentation of the milling devices. The above choices came as a result of knowledge transfer and of experimentation to advance these technologies. In other words, this applies to the concept “think globally, act locally”. Interaction and interconnectivity did exist, but there was also space for new technologies.

In the case studies reported and analyzed in Jennings’ book, it is emphasized that earlier globalizations occurred in smaller geographical regions around the world (Jennings 2014,142). The sites we studied were also focused in a smaller area, the Mediterranean. The globalization criteria proposed by Jennings, and the analysis of technological developments in sugar production occurring, indicate that globalization was prevalent in the medieval period around the Mediterranean. However, a limitation of this study is that other production centers around the globe (Aligarh in India, Tainan in Taiwan) of the same period were not investigated in this study. Therefore, although interconnectivity is attested, it should not be perceived as a truly globalized process. A future study that would incorporate all global sugar production centers, could reveal whether in this current study we should speak of globalization or Mediterraneanization.

## *Chapter 7*

## *Conclusions*

The main research question was: What can a comparative study of sugar production centers in medieval Cyprus reveal about: the origin and the purpose of the selection of certain technologies used; the ownership and human force involved in sugar production and the socio-economic dynamics at the time?

As far as the technologies are concerned, this study exposes that although the technological knowledge derived from the East, a compact "package" did not exist. It is evident that the horizontal water mill was introduced throughout Cyprus from the East (the Levant), while a vertical one at Kouklia and the presses were introduced by the Crusaders.

The vertical water mill at Kouklia had been introduced assuming that it was more efficient but proved inappropriate to Cypriot geographical and climatic conditions. Animal-driven mills were common in the first milling stage at Kouklia and Kolossi, but in Episkopi presses were operating instead. Presses existing at Kouklia and Kolossi seem to have been introduced at a later phase under Venetian rule (1489-1570). The extra-boiling room at Episkopi was another addition introduced by the Venetians. All the above changes occurred as an outcome of experimental efforts to improve productivity. The accumulated wealth of the Crusader owners enabled large-scale investments and experimentation in sugar refinery which in turn would drive further amassing of financial assets.

Another topic of investigation was the origin of the technology used in the pottery making of sugar production. The potters shared essential knowledge for the practical matters of pottery-making including the finishing techniques and the type of raw materials used. This knowledge was derived from the East where sugar production originated. Concerning the typology used, I propose that to a degree there was a repertoire used widely (Type II moulds) which was implemented by the Crusaders who owned most of the sugar production centers in the Mediterranean. However, a degree of flexibility in typology choices (molasses jars) did occur.

The investigation of the relationship between the owners of the sugar production sites revealed that Franks, Hospitallers and Venetians relied heavily on diplomacy. Nevertheless, these wealthy and powerful rulers were influenced by the fluid political circumstances and occasionally had either alliances or conflicts.

Concerning the status of those who worked in sugar production, this thesis concludes that as it was an intensive process requiring a variety of people with specialized skills, *francomati, parici* and, at one point, slaves were all employed.

This study has argued that the economic system was hybridized with characteristics of both capitalism and feudalism co-existing. In addition, concerning globalization, Jenning's model applied to an extent, as the criteria he suggested could be traced in our study. However, as there are many more sugar production centers across the world at the same period, which were not examined in this thesis, we are unable to speak of globalization in the stricter sense of the word.

This thesis provides a broad overview of sugar production in medieval Cyprus from an archaeological perspective. The archaeological evidence along with the written sources were the basis of this research. A limitation, due to Covid-19 lockdown, was the inability to visit the archaeological sites discussed and to examine first-hand the archaeological findings. Under these circumstances, this research was inevitably only literature-based. An extensive and exhaustive literature was reviewed, analyzed and summarized answering the research questions. The results of this research show that sugar production has political, economic and social dimensions.

From this research, new ideas for further investigation have arisen. Regarding the pottery production, a microscopic analysis of the molasses jars would provide evidence for their provenance. In addition, a comparative research of the sugar production centers of the $12^{th}$-$16^{th}$ centuries around the world could provide an answer to whether sugar technologies examined in this thesis were globalized or not.

## Abstract

The aim of the present research is to examine sugar cane production centers in medieval Cyprus with an in-depth exploration of the technology employed in sugar production including a comparison with other production sites around the Mediterranean. The objectives of this investigation are to trace the technological innovation, the knowledge transfer and exchange networks which existed at the time. In addition, the present study investigates the relationships of the owners, and the status of the workforce. Finally, theories related to capitalism and globalization and how they were implemented in sugar production are put forward.

The research question is investigated by examining archaeological data of the sugar production sites using online literature in combination with written sources including trade documents, travelers' accounts and state archives.

This study exposes that technological knowledge in sugar production derived from the East, but no compact "package" existed. Horizontal water mills were introduced throughout Cyprus from the East (the Levant), while a vertical one at Kouklia and the presses were introduced by the Crusaders. Concerning the pottery making technology, there was a widely used repertoire which was implemented by the Crusaders who owned most of the sugar production centers in the Mediterranean. However, a degree of flexibility in typology choices did occur. The relationship between owners of sugar production sites relied heavily on diplomacy. The workforce was diverse with *francomati*, *parici* and, at one point, slaves all employed. The economic system was a hybridization of capitalism and feudalism. Finally, the study shows that sugar production followed Jennings' model of globalization to an extent. This study of sugar production in medieval Cyprus elucidates technological, social and economic dimensions of human life.



Key words: sugar production, medieval Cyprus, mills, pottery, workforce, ownership, capitalism, globalization and combination of these words.

## ***Bibliography***


Al-Idrīsī, *Kitāb Nuzhat al-Mushtāq fī Ikhtirāq al-Āfāq*, 9 vols. Edited by Cerulli, E. Napoli-Roma: Instituto Universitario Orientale, 1970–84.

Arbel, B., 1998. Cyprus under Venice: Continuity and change in Papanikola-Bakirtzi D. and M. Iacovou (eds.), *Byzantine Medieval Cyprus*. Nicosia: Bank of Cyprus Cultural Foundation, 161-174.

Arbel, B. 2000. Slave Trade and Slave Labour in Frankish Cyprus (1191-1571), in B. Arbel (ed.), *Cyprus, Franks and Venice, 13th-16th Centuries*. Aldershot: Ashgate Variorum, 151-190.

Aristeidou, E. 1990. *Ανέκδοτα Έγγραφα της Κυπριακής Ιστορίας από το Κρατικό Αρχείο της Βενετίας, vol 1 (1474-1508).* Λευκωσία: Κέντρο Επιστημονικών Ερευνών.

Aristeidou, E. 1999. *Ανέκδοτα Έγγραφα της Κυπριακής Ιστορίας από το Κρατικό Αρχείο της Βενετίας, vol 3 (1518-1529).* Λευκωσία: Κέντρο Επιστημονικών Ερευνών.

Aristeidou, E. 2003. *Ανέκδοτα Έγγραφα της Κυπριακής Ιστορίας από το Κρατικό Αρχείο της Βενετίας, vol 4 (1530-1540).* Λευκωσία: Κέντρο Επιστημονικών Ερευνών.

Aristeidou, E., 1992. Η καλλιέργεια του ζαχαροκάλαμου και οι μεσαιωνικοί ζαχαρόμυλοι στην Κύπρο, in Γ. Ιωαννίδης (ed.), *Αφιέρωμα στον Βάσω Καραγιώργη.* Λευκωσία: Εταιρία Κυπριακών Σπουδών, 339-350.

Armstrong, D.V., 2019. Capitalism and the Shift to Sugar and Slavery in Mid-Seventeenth- Century Barbados. *Historical Archaeology* 53, 468-491.

Blaut, J. M., 1989. Colonialism and the Rise of Capitalism. *Science and Society* 53, 3, 260-296.

Borchardt, K., 2008. Documents from the Hospitaller Registers on Rhodes concerning Cyprus, 1409-1459: Form and Contents in Beihammer, A.D, M.G.

Parani and C.D. Schabel (eds.), *Diplomatics in the Eastern Mediterranean 1000-1500: Aspects of Cross-Cultural Communication.* Leiden: Brill. 159-169.

Boustronios, G., *The chronicle of Boustronios 1456- 1489*. Translated by R. M. Dawkins. University of Melbourne Cyprus Expedition, 1964.

Boustronios, G., *Chronique de l'île de Chypre*. Translated by R. de Mas Latrie. Paris, 1886.

Braudel, F., 1984. *Civilization and Capitalism 15th-18th Century Vol.2: The perspective of the World.* Translated by Reynolds, S. London: Collins.

Bresc, H., 2013. Palermo in the 14th–15th Century: Urban Economy and Trade in A. Nef (ed.), *A companion to Medieval Palermo: The history of a Mediterranean City from 600 to 1500*. Brill. Leiden Boston, 233-268.

Bronstein, J., E. Stern and E. Yehuda, 2019. Franks, locals and sugar cane: a case study of cultural interaction in the Latin Kingdom of Jerusalem. *Journal of Medieval History* 45, 3, 316-330. https://doi.org/10.1080/03044181.2019.1612185

Brumbley, S.M., S. J. Snyman, A. Gnanasambandam, P. Joyce, S. R. Hermann, J. A.G. da Silva, R. B. McQualter, M.L. Wang, B. T. Egan, A. H. Paterson, H. H. Albert and P. H. Moore 2009. Sugarcane in Kole C. and T.C. Hole (eds.) *Compendium of transgenic crop plants, vol 7, transgenic sugar, tuber and fiber corps.* London: Blackwell, 1-58. https://doi.org/10.1002/9781405181099.k0701

Burchard E.F. and W.E. Emley, 1913. Source manufacture and use of lime in *Mineral sources of the United States Part II*. Washington, 1509-1590.

Burkiewicz, L.,2016. The Hospitallers and their Sugar refinery in Kolossi in the context of cane sugar processing in Cyprus (13th-15th centuries) in D. Quirini-Popławska and Ł. Burkiewicz (eds), *Sacrum w mieście: wymiar kulturowy, religijny i społeczny, tom 1: Średniowiecze i wczesna epoka nowożytna.* Kraków: Akademia Ignatianum, 111-130.

Casola, P., *Canon Pietro Casola's Pilgrimage to Jerusalem in the Year 1494.* Translated by M. Newett. Manchester, 1904.

Cobham, C.D., 1908. *Excerpta Cyprus: Materials for History of Cyprus.* Cambridge: Cambridge University Press.

Coureas, N., 2008. Commercial Relations between Cyprus and Constantinople during the Fourteenth Century, *Επετηρίδα του Κέντρου Επιστημονικών Ερευνών* XXXIV,121-136.

Coureas, N., 2013. Hospitaller Estates and Agricultural Production on Fourteenth- and Fifteenth- Century Cyprus. in E., Buttigieg and S., Phillips (eds.), *Islands and Military Orders, c.1291-c.1798.* Oxford: Taylor and Francis Ltd., 215-224.

Coureas, N., 2017. The lousignan kingdom and the Sea, 13th-15ht centuries in Buchet C. and M., Balard (eds.), *The sea history- The Medieval World.* Sufflock: Boydell & Brewer, 369-381. https://doi.org/10.1017/9781782049104.035

Cordoba R. and U. Muller 2011. Craft into Industry in Carver M. and J. Klapste (eds.), *The archaeology of Medieval Europe, Vol 2: Twelfth to Sixteenth Centuries.* Aarhus: Aarhus University Press, 277-286.

Deerr, N., 1949-1950. *The History of Sugar*, 2 vols. London: Chapman and Hall Ltd.

Deerr, N., 1911. *Cane Sugar: A text-book on the agriculture of the sugar cane, the manufacture of cane sugar, and the analysis of sugar house products; together with a chapter on the fermentation of molasses*. London: Norman

Demesticha, S., 2019. Shipwrecks: tracing the role of Cyprus in the seaborne trade networks of the eastern Mediterranean, in the website: *Kyprios Character. History, Archaeology and Numismatics of Ancient Cyprus:* kyprioscharacter.eie.gr/en/t/A6, accessed: 2 July 2020.

Devaney, T., 2013. Spectacle, Community and Holy War in Fourteenth-Century Cyprus, *Medieval Encounters* 19, 3, 300-341. https://doi.org/10.1163/15700674-12342140

Di Schino, J., 2014. The Significance and Symbolism of Sugar Sculpture at Italian Banquets in M. McWilliams (ed), *Food&Material Culture: Proceedings of the Oxford Symposium on Food and Cookery 2013*. Totnes, Devon: Prospect Books, 111-122.

Diderot, *Sucre, Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers, vol. 15. Paris, 1765.* Translated by N.J. Andrews. Ann Arbor: Michigan Publishing, University of Michigan Library 2006, in web http://hdl.handle.net/2027/spo.did2222.0000.584 Accessed on 2/07/2020

Dincer, A., 2016. Enslaving Christians: Greek Slaves in Late Medieval Cyprus, *Mediterranean Historical Review* 31,1. Doi: 10.1080/09518967.2016.1193944

Edbury, P.W., 1991. *The Kingdom of Cyprus and the Crusades, 1191-1374.* Cambridge: Cambridge University Press.

https://doiorg.ezproxy.leidenuniv.nl:2443/10.1017/CBO9780511751714

Falsone, G., 1974. "Forme" e "Cantarelli". I vasi per la raffinazione dello zucchero alla luce dei recenti rinvenimenti dello Steri, *Sicilia Archaeologica* 24-25, 103-112.

Forbes, R.J., 1966. *Sugar and its Substitutes in antiquity in Studies in ancient technology, vol 6.* Leiden: Brill, 80-104.

Frankel R. and E. Stern, 1996. A Crusader Screw Press from Western Galilee- The Manot Press. *Techniques and Culture* 27, 89-123.

Galloway, J.H., 1977. The Mediterranean sugar industry, *Geographical Review* 67, 2, 177-194.

Gies, F. and J. Gies, 1994. *Cathedral, Forge and Waterwheel: technology and invention in the middle Ages.* New York: Harper Perennial.

Gimpel, J., 1976. *The Medieval Machine: The industrial Revolution of the Middle Ages.* New York: Penguin Books.

Given, M. 2000. Agriculture, Settlement and Landscape in Ottoman Cyprus. Levant 32, 1, 215-236. Doi: 10.1179/lev.2000.32.1.209

Germanidou, S., 2014. Watermills in Byzantine Greece (Fifth-Twelfth Centuries): A preliminary approach to the archaeology of Byzantine Hydraulic Milling Technology. *Byzantion* 84, 185-201.

Gow, A.S.F and D.L., Page 1968. *The Greek Anthology: The Garland of Philip and some contemporary epigrams*. Cambridge: Cambridge University Press.

Greenfield, M., 1979. Sugar, Plantations and Slavery. *Historical Reflections* 6, 1, 85-119.

Hamarneh, S., 1976. Sugar-cane Plantation and Industry under the Arab Muslims during the Middle Ages in *Proceedings of the First International Symposium for the History of Arabic Science.* Aleppo University. 221-261.

Hancock, J. F., 2017. *Plantation Crops, Plunder and Power: evolution and exploitation.* New York: Routledge.

Harvey, A., 1990. *Agricultural Production in Economic expansion in the Byzantine Empire, 900-1200.* Cambridge: Cambridge University Press. 120-162.

Hill, G., 2010. *A history of Cyprus*. Volumes 2-3. Cambridge: Cambridge University Press.

Hodos, T., 2017. Globalization. Some basics. An introduction to the Routledge Handbook of Archaeology and Globalization in T. Hodos (ed.), The Routledge Handbook of Archaeology and Globalization. New York: Routledge, 3-11.

Ionas, I., 1994. Subsistence Economy in Cyprus. *Επετηρίς του Κέντρου Επιστημονικών Ερευνών* 20, 433-453.

Jacoby, D. 2009. The Venetians in Byzantine and Lusignan Cyprus: trade, settlement and politics in A. Nicolaou-Konnari (ed.), *Η Γαληνοτάτη και η Ευγενεστάτη. Η Βενετία στην Κύπρο και η Κύπρος στη Βενετία*. 59-100.

Jacoby, D., 2014. Cypriot Gold Thread in Late Medieval Silk weaving and Embroidery, in S. B., Edgington and H.J., Nicholson (eds.), *Deeds Done Beyond the Sea: Essays on William of Tyre, Cyprus and the Military Orders.* Farnham: Ashgate Publishing Ltd.,101-114.

Jennings, J. 2014. *Globalizations and the Ancient World.* Cambridge: Camridge University Press.

Jones, R.E, 2016. *Sweet Waste: A view from the Mediterranean and from the Excavations at the Tawahin es Sukkar (Safi), Jordan*. Oxford: Potingair Press.

Johnson, M., 2010. Historical Archaeology, in *Archaeological theory: An Introduction*. John Wiley & Sons.

Kaldor, N., 1977. Capitalism and industrial development: some lessons from Britain's experience. *Cambridge Journal of Economic* 1,2, 193-204. https://doi.org/10.1093/oxfordjournals.cje.a035358

Karsten, L., 2012. *Globalization and time*. London: Routledge.

Kollias, I. and M., Michaelidou, 1997. Το μεσαιωνικό εργαστήριο επεξεργασίας ζάχαρης της Ρόδου In Kollias, I. and M., Michaelidou (eds.), *Τεχνογνωσία στην Λατινοκρατούμενη Ελλάδα, Ημερίδα Αθήνα, 8 Φεβρουαρίου 1997* Αθήνα: Πολιτιστικό Ίδρυμα ΕΤΒΑ, 36-49.

Kollias, I. and M., Μichaelidou, 2004. Βιοτεχνικές εγκαταστάσεις παραγωγής κατά το Μεσαίωνα στην νοτιοανατολική Μεσόγειο και τη Ρόδο, in Σ. Στάικου (ed.), *Αρχαιολογικά τεκμήρια βιοτεχνικών εγκαταστάσεων κατά την Βυζαντινή Εποχή (5ος-15ος αι.).* Πειραιάς: Πολιτιστικό Ίδρυμα Ομίλου Πειραιώς, 11-26.

Lafrance, X. and C., Post, 2016. Introduction in X. Lafrance and C., Post (eds.), *Case studies in the origins of capitalism*. London: Palgrave Macmillan,1-38.

LaGro, H.E., 2009. Ayyubid- Mamluk Sugar pottery from Tell Abu Sarbut, Jordan. *Leiden Journal of Pottery Studies* 25, 63-102.

Lippmann, E.O.,von, 1890. Geschichte des Zuckers*: seiner Darstellung und Verwendung, seit den ältesten Zeiten bis zum Beginn der RübenzuckerFabrikation* Leipzig: Max Hesse's Verlag.

Lock, P., 2013. *The Franks in the Aegean, 1204-1500*. New York: Routledge.

Lucas, A. R., 2005. Industrial Milling in the Ancient and Medieval Worlds: A Survey of the Evidence for an Industrial Revolution in Medieval Europe. *Technology and Culture* 46, 1, 1-30.

Lucas, A. R., 2006. *Wind, Water, Work: Ancient and Medieval Milling technology.* Leiden: Brill.

Lucas, A. R., 2010. Narratives of the technological Revolution in the Middle Ages in Classen A. (ed.), *Handbook of Medieval Studies: Terms- Methods- Trends. Berlin: De Gruyter,* 967-990.

Lynch, A.J. and C.A., Rowland, 2005. *The history of grinding*. Littleton, Colorado: Society for Mining, Metallurgy, and Exploration.

Makheras, L., *Chronique de Chypre.* Translated E. Miller and C. Sathas Paris, 1882.

Mas Latrie, L., 1882. Documents nouveaux servant de preuves à l'histoire de l'île de Chypre sous le règne des princes de la maison de Lu signan, *Mélanges Historiques* 4.

Marx, K., *Capital: a Critique of Political Economy*, vol I. Translated S. Moore and E. Aveling. Moscow: Progress Publishers, 1887.

Mazumdar, S., 1998. *Sugar and Society in China: Peasants, Technology, and the World Market.* Cambridge, Massachusetts: Harvard University Press.

McNeil, W. H., 2008. Globalization: long term process or new era in human affairs. *New Global Studies* 2,1, 1–9.

*Merriam-Webster's Collegiate Dictionary* (10th ed.) 1999. Merriam-Webster Incorporated.

Milwright, M., 2008. *The Fortress of the Raven: Karak in the Middle Islamic Period, 1100-1650*. Leiden: Brill.

Mintz, S., 1985. *Sweetness and power.* New York: Viking.

Moschonas, N., 2001. *Κύπρος: Σταυροδρόμι της Μεσογείου*. Αθήνα: Εθνικό Ίδρυμα Ερευνών.

Müller-Wodarg, D., 1956. Die Landwirtschaft Ägyptens in der frühen ʿAbbasidenzeit. *Der Islam* 32, 14-78.

Murray, W., 1995. Ancient sailing winds in the eastern Mediterranean: the case for Cyprus, in V. Karageorghis and D. Michaelides (eds.), *Proceedings of the International Symposium "Cyprus and the Sea" organized by the Archaeological Research Unit of the University of Cyprus and the Cyprus Ports Authority, Nicosia 25-26 September 1993.* Nicosia: University of Cyprus, 33-44.

Nerantzi- Varmazi, V., 1995. *Μεσαιωνική ιστορία της Κύπρου μέσα από τις Βυζαντινές πηγές*. Θεσσαλονίκη: Εκδόσεις Βάνιας.

Nicolaou-Konnari, A., 2005. Greeks. in A. Nicolaou-Konnari and C. Schabel (eds.), *Cyprus. Society and Culture, 1191-1374*. Leiden: Brill, 13-62.

Nicolaou-Konnari, A., 2018. Συνέχειες και ασυνέχειες στη δουλοπάροικιακή πολτική της βενετικής διοίκησης στην Κύπρο in Lamprinos K. (ed.), *Κοινωνίες της υπαίθρου στην ελληνοβενετική Ανατολή (13ος-18ος αι.)* Αθήνα: Κέντρον Ερεύνης του Μεσαιωνικού και Νέου Ελληνισμού της Ακαδημίας Αθηνών. 51-92.

O'Rourke, K. H. and J. G. Williamson, 2002. When did globalisation begin?, *European Journal of Economic History* 6, 23–50.

Ouerfelli, M., 2008. *La sucre. Production, commercialisation et usages dans la Méditerranée médiévale.* Leiden: Brill.

Ouerfelli, M. 2016. La production du sucre en Méditerranée médiévale. Peut-on parler d'un système esclavagiste?, *Rives méditerranéenne*s 53, 41-59. Doi: 10.4000/rives.5147

Papanikola- Bakirtzi, D., 1994. *Cypriot Medieval glazed pottery. Workshops of Lemba and Lapithos*. (unpublished Phd thesis in Aristotle University of Thessaloniki). Doi: 10.12681/eadd/3687 AuTh

Pegolotti, F. B. *La Pratica della Mercatura*. Edited by Evans A. Cambridge,1936.

Phillips, W.D., 2018. Slavery in Late Medieval Europe in D.A Pargas and F. Rosu (eds.), *Critical readings in global slavery*. Leiden: Brill, 665-698.

Plana, J., 1992. The accounts of Joan Benet's Trading Venture from Barcelona to Famagusta: 1343. *Επετηρίς του Κέντρου Επιστημονικών Ερευνών* 19, 105-68.

Politis, K., 2010. The sugar industry in the Ghawr aṣ-Ṣāfī, Jordan, *Studies in the history and archaeology of Jordan* 11, 467-480.

Politis, K., 2015. Earliest Evidence for an Arab Sugarcane Industry with a focus on the southern Bilad ash-Sham in Politis K. (ed.), *The Origins of Sugar industry and the Transmission of the Ancient Greek and Medieval Arab Science and Technology from the Near East to Europe*. Athens: National and Kapodistriako University of Athens. 25-42.

Pringle, R.D and P.E, Leach, 1986. A Thirteenth- Century Hall at Montfort Castle in Western Galilee. *Antiquaries Journal* 66, 55-81.

Regaldo-Saint-Blancard, P., S. Fescia-Bordelais and A. Duverneuil, 1986. Les céramiques de raffinage du sucre: typologie, technologie, *Archéologie du midi medieval* IV, 151-168.

Reynolds, T.S. 1983. *Stronger than a Hundred men: A history of the vertical water wheel.* Baltimore: The Johns Hopkins University Press.

Riley-Smith, J., 1967. The Knights of St. John in Jerusalem and Cyprus, 1050-1310. London: Macmillan St. Martin's Press.

Rizopoulou- Igoumenidou, E. 2006. Οι υδροκίνητοι μύλοι της Κύπρου: Καταγραφή, Έρευνα, Δημοσίευση in Μ., Γρυπάρη and Δ. Δαμιανού (eds.), *Το νερό στα παραδοσιακά ενεργειακά συστήματα του Αιγαίου, της Θράκης και της Κύπρου.* Αθήνα: Ινστιτούτο των Ελληνικών Μύλων, 81-99.

Rünger, T., 2019. Medieval Watermills – Diffusion, Control and Beneficiaries of a Powerful Technology in Annaert R. (ed.), *Early medieval waterscapes Risks and opportunities for (im)material cultural exchange*. Braunschweig: Braunschweigisches Landesmuseum, 115-126.

Sachs, J., 2020. *The Ages of globalization. Geography, Technology and Institutions.* Columbia: Columbia University Press.

Sanudo, M. *Liber secretorum fidelium crucis*. Published by J. Bongars, Gesta dei per Francos II, Hanover: Reprint: Massada Press, Jerusalem, 1972.

Schwartz, S.B., 2004. *Tropical Babylons: Sugar and the Making of the Atlantic World, 1450-1680*. Carolina: North Carolina Press.

Shulman, C. 2017. *A Tale of Three Thirsty Cities: The Innovative Water Supply Systems of Toledo, London and Paris in the Second Half of the Sixteenth Century*. Leiden: Brill.

Simpson, I.R., 2019. Framings of Capitalism and the Archaeology of Sugar in the Islamic Mediterranean, *Historical Archaeology* 53, 3, 1-20. Doi: 10.1007/s41636-019-00212-9

Smith, A. *The Wealth of Nations*. New York: Bantham. 2003

Smith, A.F., 2015. *Sugar: A Global History*. London: Reaktion Books.

Smith, W. 1875. *A dictionary of Greek and Roman Antiquities*. London: Murray J.

Solomidou-Ieronymidou, M., 1998. The production of sugar in Medieval Cyprus, in Papanikola- Bakirtzi D. and M. Iacovou (eds.), *Byzantine Medieval Cyprus.* Nicosia: Bank of Cyprus Cultural Foundation, 65-71.

Solomidou- Ieronymidou M. 2005. Ο Μεσαιωνικός ζαχαρόμυλος του Κολοσσίου. *Αρχαιολογία και Τέχνες* 96, 45-51.

Solomidou-Ieronymidou, M., 2015a. Sugar mills and sugar production in Medieval Cyprus, in S. Rogge and M. Grünbart (eds.), *Medieval Cyprus: a Place of Cultural Encounter*. Münster: Waxmann, 147-174.

Solomidou-Ieronymidou M. 2015b. The Medieval Sugar-Mills of EpiskopiSerayia Serayia and Kolossi and Sugar Production in Medieval Cyprus in Politis K. (ed.) *The Origins of Sugar industry and the Transmission of the Ancient Greek and Medieval Arab Science and Technology from the Near East to Europe.* Athens: National and Kapodistriako University of Athens. 129-145

Stern, E., 2001.The excavations at Lower Horbat Manot: A Medieval Sugar Production Site. *'Atiqot* 42, 277-308.

Stern, E., 2015. Sugar Production in the 'Akko Plain from the Fatimid to Early Modern Periods in Medieval Cyprus in Politis K. (ed.), *The Origins of Sugar industry and the Transmission of the Ancient Greek and Medieval Arab Science and Technology from the Near East to Europe*. Athens: National and Kapodistriako University of Athens. 79-112.

Suatriti, P., 1998. *Water and society in early medieval Italy, AD400-1000.* Cambridge: Cambridge University Press.

Sweezy, P.M. and M. Dobb, 1950. The Transition from Feudalism to Capitalism, S*cience and Society* 14, 2, 134-167.

Taxel, I., 2013. The olive oil economy of Byzantine and Early Islamic Palestine: Some Critical notes. *Liber Annus* 63, 361-394.

Theophrastus, *Theophrasti Eressi quae supersunt opera: et excerpta librorum.* Edited by G. Schneider and D.H.F. Link. Lipsiae, 1818.

Tsugitaka, S., 2015. *Sugar in the Social Life of Medieval Islam*. Leiden: Brill.

Tullio, A., 1997, Strumenti per la lavorazione dello zucchero a Maredolce (Palermo), *Archeologia e territorio*, 471-479.

Walker, B.J., 2008."Twixt Cross and Crescent": Caari and the Cultural History of Crusader and Islamic Cyprus. *Near Eastern Archaeology* 71, 1/2, 104-110.

Wartburg, M.-L., von, 1983. The Medieval Cane Sugar Industry in Cyprus: Results of Recent Excavation. *Antiquaries journal 63*, 298-314.

Wartburg, M.-L., von and F.G., Maier, 1989. Excavations at Kouklia (Palelaphos): 15th preliminary report: seasons 1987 and 1988. *Report of the Department of Antiquities Cyprus*, 177-188.

Wartburg, M.-L., von, 2001. The archaeology of cane sugar production. A survey of twenty years of research in Cyprus. *Antiquaries journal* 81, 305–335.

Wartburg, M.-L., von, 2014. Ubiquity and conformity: A comparative study of sugar pottery excavated in Cyprus, in D. Papanikola-Bakirtzi and N. Coureas (eds.), *Cypriot Medieval Ceramics. Reconsiderations and New Perspectives*. Nicosia: The Cyprus Research Center and The A. G. Leventis Foundation, 213-245.

Wartburg, M.-L., von, 2015. Medieval Cane Sugar Production in Cyprus: A Review of Archaeological and Textual Evidence with a Focus on Specific Technological and Economic Developments in in Politis K. (ed.) *The Origins of Sugar industry and the Transmission of the Ancient Greek and Medieval Arab Science and Technology from the Near East to Europe.* Athens: National and Kapodistriako University of Athens. 147-165.

Watson, A., 1974. The Arab Agricultural Revolution and Its Diffusion, 700-1100. *The Journal of Economic History* 34, 1, 8-35.
https://doi.org/10.1017/S0022050700079602

Wikander, Ö., 2000. The water mill in *Handbook of Ancient water technology.* Leiden: Brill, 375-200.

Wilson A. 2002. Machines, Power and Ancient Economy. *The Journal of Roman Studies* 92, 1-32.

Wilson, A., 2020. Roman Water Power: Chronological Trends and Geographical Spread in Erdkamp P., K. Verboven and A. Zuiderhoek (eds.), *Capital, Investment and Innovation in the Roman World.* Oxford: Oxford Press, 147-194.

Wolf, E. R., 1997. *Europe and the People without History*. University of California Press, Berkeley.

Wood, E. M., 2002. *The Origin of Capitalism: A Longer View*. London: Verso Books.

Κυπριανός, Αρχιμανδρίτης 1933. *Ιστορία Χρονολογική της νήσου Κύπρου*. Λευκωσία: Γλύκης 1971.

Ancient sources

Dioscorides, *De Materia Medica*. Translated by Beck, L. Y. Hildesheim: Olms-Weidmann, 2005.

Pliny, *Historia Naturalis*. Translated by J. Bostock and H. T. Riley. London: Henry C. Bohn, 1855.

Pseudo- Arrianus, *Geographi Graeci minores*, vol. 1. Edited by K. Müller. Paris: Didot, 1855.

Strabo, *Geographica*. Edited by A. Meineke. Leipzig: Teubner, 1877.

*Suidae Lexicon.* Edited by I. Bekker. Berlin 1854.

Vitruvius, *De architectura.* Translated by Morgan M.H. Cambridge: Harvard University Press. London: Humphrey Milford. Oxford University Press, 1914.

Xenophon, *Anabasis.* Translated by C.L. Brownson. Harvard University Press, Cambridge, MA; William Heinemann, Ltd., London. 1922.

Online sources

https://www.who.int/publications-detail/9789241549028 , accessed on 2 July 2020.

https://www.nytimes.com/2019/12/30/well/eat/sugar-diet-healthy.html, accessed on 2 July 2020.

https://dictionary.cambridge.org/dictionary/english/colony, accessed on 2 July 2020.

https://www.youtube.com/watch?v=xLi5-TNdNag ,accessed on 2 July 2020.

https://www.britishmuseum.org/collection/object/P_1948-0410-4-203, accessed on 2 July 2020.

https://www.britishmuseum.org/collection/object/P_1948-0410-4-203, accessed on 2 July 2020

https://digital.lib.uh.edu/collection/p15195coll29/item/121 , accessed on 2 July 2020

http://www.slaveryimages.org/s/slaveryimages/item/2165 , accessed on 2 July 2020

http://www.slaveryimages.org/s/slaveryimages/item/1113 , accessed on 2 July 2020

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