beverages

Review

Historical and Heritage Sustainability for the Revival of Ancient Wine-Making Techniques and Wine Styles

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Abstract: The purpose of this review is to provide a general description of ancient winemaking techniques and wine styles that were most lauded in antiquity, in support of their revival and dissemination today. From the first fully excavated winery, dating from the late fifth to the early fourth millennium BC, the gentle crushing of grapes by foot and the probable absence of maceration indicate that most wines were made with the aim of reducing astringency. The oxidative nature of winemaking would have resulted in rapid browning, so that wines made from red grapes would have had a similar color to those made from white grapes after being aged in clay vats for several years. The difficulty in preventing the wine surface contact with the air would have resulted in biological ageing under the yeast pellicle being a common occurrence. This phenomenon was not considered a flaw, but a characteristic feature of highly prized wines. Dried grapes were used to make sweet wines, which were also highly prized, therefore justifying the construction of dedicated facilities. The addition of boiled juices, salt, resins, mixtures of herbs, spices, fruit juices, flowers, or honey to the wines would have increased their taste pleasantness while improving their preservability and medicinal properties. Indeed, today's preference for flavored wines with a soft mouthfeel seems to have been representative of the ancient elite consumers. Overall, the technical interpretation of winemaking described in this review will provide solid historical support for the current rebirth of ancient production methods, particularly those using pottery vessels.

Keywords: heritage winemaking; clay vessels; biological aging; wine styles; aged wines; sweet wines; consumer preferences; wine trends

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1. Introduction

Viticulture emerged in the Neolithic period (10,000–4000 BC) in the South Caucasus region [1,2] and subsequently spread throughout the Mediterranean [3]. Ancient viticultural and oenological practices were described by the most famous Roman authors in their agricultural treatises—Cato (*c.* 234–149 BC), Varro (*c.* 116–27 BC), Pliny the Elder (*c.* AD 23/24–79), Columella (*c.* 1st century AD), Palladius (late 4th/early 5th century AD), and an anonymous treatise (based on works by ancient authors) from the 10th century AD Byzantine Greek agricultural manual *Geoponika* [4]. The interpretation of archaeological finds and written sources has been described in detail by Tchernia and Brun [5], Thurmond [6], McGovern [3], and Dodd [4]. These authors have provided a wealth of knowledge based on their historical and archaeological backgrounds. However, there is a lack of interpretation of the ancient sources based on recent advances in wine science and technology. Moreover, the sustainability of wine requires not only environmental considerations, but also a thorough exploration of the historical aspects and cultural heritage underlying its production [7,8].

The aim of this review is, therefore, to present an updated interpretation of the earliest historical events related to the routes of winemaking dissemination from the perspective

of researchers with backgrounds in oenology. Particular emphasis has been placed on selected examples that can illustrate the techniques, wine styles, and consumer preferences described in antiquity. It is hoped that wine professionals will gain a comprehensive technical description that will support and justify efforts to develop sustainable wines based on ancient techniques.

2. Understanding Winemaking in the Earliest Wineries

2.1. The Armenian Areni-1 Winery

Figure 1 shows the locations of the earliest findings related to winemaking in the South Caucasus, described by McGovern [3], and in the Levant.

Figure 1. Regions and locations related to the onset of winemaking (adapted by M. Harutyunyan).

In southern Armenia, the oldest known wine production facility in the world was discovered, dating back 6100 years. Excavations at the Areni-1 site were carried out in 2007 and 2010 [1,9,10]. Areni-1 is described as a large *karst* cave with three chambers located on the left side of the Arpa River basin in the eastern part of the village of Areni in Vayots Dzor province. Finds in the cave include two well-preserved cylindrical bread ovens, grain, wine storage vessels, wine-soaked sherds, drinking cups, associated pottery, glass fragments, organic remains, and other small finds (Figure 2). The cave contains archeological cultural layers dating from the Neolithic to the Late Medieval period, with the most important finds belonging to the Chalcolithic (5500–3400 cal BC) [9].

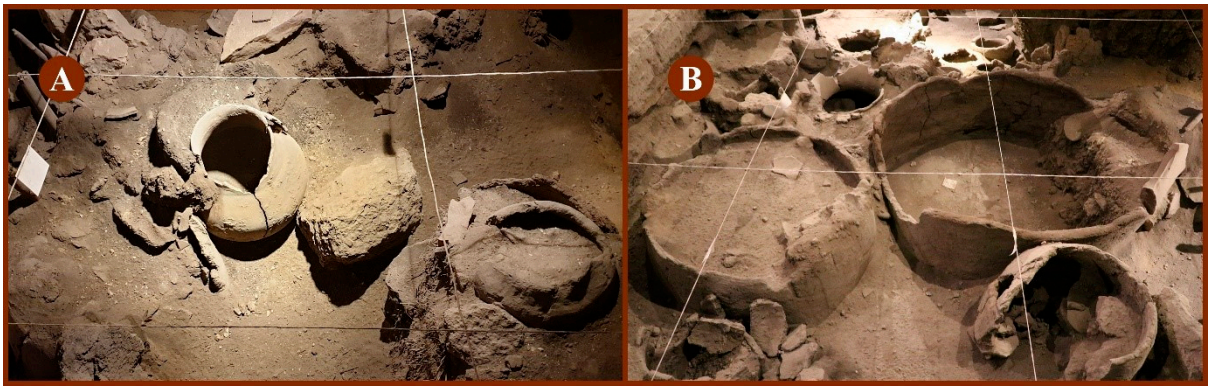

Figure 2. Wine production facility in Areni-1 cave complex. (**A**) small clay jar ("karas") and (**B**) clay storage constructions. Photo credit: M. Harutyunyan.

The wine-making facility was evidenced by the discovery of a clay basin (*aragast*) with a clearly visible slope for treading grapes and a pressed clay container (*taqar*) for collecting the mash and/or grape juice on the floor. In addition, numerous vessels of various sizes were excavated for sediment separation, wine storage, and maturation [9–11]. During the "winemaking process", fresh grapes were trodden into the *aragast*, probably with bare feet. This shallow basin (1 m long) was made of hard clay surrounded by a thick rim to contain the juices, which flowed by gravity into the buried *taqar* (at 60 cm deep, with a capacity of about 55 L) for fermentation and storage. Some of the pots were covered with lids made of stone slabs, while the mouths of others were covered with clay, preserving traces of fingerprints well for such a long time. The plastering of the jar mouths would have created an air lock, while the constant low humidity and stable temperatures in the cave aided the preservation of the wine [9]. The size of the clay fermentation vessels strongly resembles those still found in the region today and can be considered as precursors of the Greek *pithoi* [12], Roman *dolia* [13], Armenian *karases* [14], Georgian *qvevri* [15], or Portuguese *talhas* [16].

A variety of *Vitis* spp. remains were recovered from Areni-1. The remains, which date from the Late Chalcolithic (4230–3970 cal. BC) to the High Medieval (800–1300 cal. AD), include grape seeds, skins, stems, pomace remains, and dozens of desiccated (non-carbonated) vines that were excavated. The remains of grape seeds found in the vessels were from domesticated vines, indicating the cultivation of grapevines [9,11]. Furthermore, the presence of tartaric acid and the red pigment anthocyanin malvidin indicated that the jars contained red wine [1]. Thus, this appears to be the first reliable evidence of sophisticated "industrial scale" wine production. This winery was found in a cave, but later open-air facilities in rocks were found near the vineyards.

2.2. The Basic Rock-Cut Field Treading Installation

Archaeologists currently use the term winepress for all sites associated with wine production. According to Frankel [17], however, it should be reserved for true presses, while for sites consisting only of a treading floor and collecting vessels it would be better to use the term "treading facility" or "wine cellar".

After the Chalcolithic, there are relatively few examples of systematic wine production in the Near East until the Late Bronze Age [18,19]. At Aphek, on the central coast of Israel, a large winery (two "winepresses" and storage *pithoi*) constructed of plaster and stones was found around the walls of a palace (*c.* 13th century BC). It was not located in the field, probably to ensure control by the ruling unit, as Gadot [20] suggests. In fact, wineries from this period to the following Iron Age are best represented by the numerous examples of rock-hewn enclosures near vineyards mentioned in the Bible. Both Isaiah (5:2) and Matthew (21:33) contain descriptions that refer to a landowner who planted a vineyard, built a wall around it, raised a "winepress" into it, and built a tower [21].

The Israeli vineyard of Jezreel (10th–9th century BC) described by Franklin [22] can be considered a typical example of the Iron Age. Most of the 117 sites investigated by this author in the area consisted of a rectangular stepped floor with a rectangular vat and were generally located outside the village and cut into the edge of the rocky outcrop adjacent to the fields. A roughly triangular depression in the center of the tread floor was probably used to collect grape skins, seeds, and stems, which formed a block around which the juice flowed into the cistern carved into the rock for primary fermentation. Primary fermentation continued in this vat for a short number of days [23]. The wine was then strained into jugs that were stored in another cool place for the second fermentation, probably in the palace of the ruler [24]. Considering that spontaneous fermentation can take five to seven days at ambient temperature, it would not be efficient to keep these cisterns occupied for such a long time during harvest.

Other wineries from the same period had the same type of facility, but were smaller. In these cases, the treading and the vessel were built together as one structure with no pipe connections [25]. In some of these small installations, the reception pits occurred in pairs, had a round or elliptical shape, and were well plastered. These simple wine cellars were not always carved into the rock. In the coastal areas of the Levant, near the present-day city of Jaffa (10th–9th century BC), for example, where there was no bedrock, the basins were made of plaster mixed with crushed shells [26]. In southern Lebanon, the wine-archaeological site of Tell el-Burak (8th–6th century BC) demonstrates the early use of lime plaster by contemporary Phoenicians, who flourished roughly between 1500–300 BC [27]. In an even simpler device, treading could be done in portable clay floors or tubs [28].

Greenberg and Cinamon's [29] excavations near Jerusalem attested to the development of these devices from the Iron Age II (8th–6th century BC) through the Persian period (6th–4th century BC) to the early Roman period (1st century BC–1st century CE). The older examples showed the typical stepped floor, with or without a settling basin and collecting vat. Interestingly, adjacent caves or plastered cistern-like rooms, some with stairs, may have been used for the storage or fermentation of juices/wines derived from several settling basins.

Other studies have shown a close parallelism between contemporary Levantine and Anatolian rock-cut wine cellars. According to Diler [30], the simple type of rock-hewn wine cellars may have been introduced to Cilicia (southeastern Turkey) from the Palestine region. From Cilicia, it then reached Phrygia (west-central part of Anatolia, present-day Turkey) in the eight to seventh centuries BC [31]. However, in technological terms, these wineries were quite similar to the earlier Areni-1, except for the location of the cave. Then we can speculate that the process was transferred in parallel from the South Caucasus to the Anatolian plateau and to Palestine.

The Introduction of Grape Presses

The clue to the approximate dating of the earlier Levantine vineyard sites in technological terms was the absence of pressing facilities [32]. However, the absence of pressing does not seem to make sense from a technological and economic point of view, since this process increases the volume of wine by about 25%, at least. The answer may lie in Egyptian depictions of groups of men turning sacks, squeezing grapes, and draining the juice. The process was particularly adventurous as the men walked around in a horizontal position and squeezed the sacks using poles. In addition to these scenes, various technical practices are described in great detail (vineyard and grape treading, straining and pressing grape juice, picking, crushing, grape harvesting and fowling, winepress scene with sealed and unsealed wine jars) from the time of the Old Kingdom (2575–2150 BC) to the 18th Dynasty (1539–1292 BC) and during the New Kingdom period (1539–1075 BC) [33–35]. These bag presses have not been detected in the previously mentioned rock-cut field cellars, but may have simply disappeared due to their perishable nature. In our opinion and taking into account that the Canaanites (3rd–2nd millennium BC) introduced viticulture and winemaking to Egypt [3] and that the pharaohs ruled the region during part of the Bronze Age (the

above-mentioned Aphek palace was ruled by the Egyptians), the pressing process in the field wineries should have been carried out in a similar way.

The type of elements found in winepresses in later periods in the Levant, Greece, and Rome were basically the same as those added to the press to squeeze the trodden grapes. Frankel [17] noted that the first advance in pressing was the introduction of the simpler lever and weight press in Syria and Cyprus during the Bronze Age (*c.* 1400 BC). The popularity and effectiveness of these presses is reflected in their regular appearance in the Near East from Roman times to Late Antiquity (5th–6th century AD) [36]. Greenberg and Cinamon [29] noted that in the Iron Age, Persian Period, and Early Roman Period, niches were cut into the back wall of treading floors in which pressed beams could be anchored. The same type of facilities was found by Avrutis [19] in a quarry in southern Israel and illustrates 1000 years of development since the former foundation stone facilities of the Persian (6th–4th century BC) and early Roman periods (1st century BC) with cisterns carved into the rock, plastered floors, and channels. The next type of press consisted of a lever and screw, followed by a direct screw system, which was widely used in the Roman period and represents a significant improvement in the process throughout the Mediterranean [4,36–38].

The development of grape presses is particularly important for archaeologists' understanding and dating of technological advances in antiquity. In terms of their influence on wine styles, the importance is much less, as the separation of the press juice was a common practice regardless of the type of equipment, being possible to separate the free-running juice and several differently colored and astringent fractions.

2.3. Winemaking in Winery Buildings

The first built wineries resembled the earlier rock-cut facilities, but consisted of masonry walls, paved floors, and collecting vats of various shapes. The increasing size and complexity of the wine presses and grape drying floors perhaps explains the decision to build adequate facilities to support a growing commercial activity.

2.3.1. Viticulture in the Kingdom of Van

The archaeological evidences from the period of the Kingdom of Van, also known as the Urartian Kingdom (from the half of the 9th century to the end of the 7th century BC: Middle and Late Iron Ages) attest to the importance of wine production in the Armenian Plateau at the same time as the Levantine Iron Age facilities.

During the excavations at the archaeological site of Teishebaini (now known as Karmir Blur or "Red Hill"), located in the south-eastern part of Yerevan (Armenia's capital), rows of 450 *karases* and jars containing 400,000 L of wine buried in the ground were found in eight well-preserved wine storerooms. The largest room was more than 300 m^2 and was located on the second floor of the citadel. It contained 120 *karases* arranged in five rows [14,39]. The Urartians left the wine in the *karases* under the sun (3/4 buried in the ground). To improve the quality of the wine and accelerate fermentation, it was recommended to dip burning hot stones into the *karases* [40] and to smoke them with sulphur before long-term storage [14]. *Karases* were considered the most effective means of preserving grapes covered with lees. If there was no sediment, sand was poured on the bottom of the vessels [41]. Clay *karases* were made impermeable by coating the inner and/or outer surfaces with animal fat (e.g., goat fat), beeswax, or dark brown/black melted tar [39]. There were also small vessels for transporting wine, called *karasadzag*, which were carried by a donkey or a horse-drawn cart. Other movable or immovable containers for storage were wine sacks made of animal skins (e.g., goat, ox or buffalo), *gub*, or pits plastered with lime. To improve both the wine's taste and smell qualities, the Urartians mixed different oils and spices [41]. The transport vessels were also used for other beverages (beer), oils (sesame), cheese, flour, grain, and various agricultural products [39,42].

The cultural traditions of viticulture and enology established at the time of the Van Kingdom continued. Therefore, the Armenian influence on Greek, Levantine, and Roman winemaking techniques seems to have been largely underestimated.

2.3.2. Winemaking in the Greco-Roman World

- The western Mediterranean wineries

The earliest wineries, which may somewhat resemble those of today, are described in various classical Roman manuals, which list the utensils and equipment required, the location and orientation of the building, the layout of the equipment, and also hygienic procedures and instructions for winemaking [6,43,44]. The buildings of the winery included the *cella vinaria* for the treading floor (*calcatorium*), the press (*torcularium*) connected to two lower vats (*lacus*). The juices of different qualities coming from the presses were separated. Channels or clay pipes conducted the juice from the vats to the *dolia* for fermentation. Fermentation took place in a succession of *dolia* that could last from several days to months. These were dug into the sand to different heights depending on the type of wine (*dolia defossa*) and could be in the open air or under a roof. The stronger, astringent wines were stored in above-ground *dolia* (*orcae*), while the more delicate wines were kept underground. Smaller *dolia*, called *seriae* (with a capacity of about 7 amphorae, about 180 L), were used for the better wines. In between, wooden casks (*cupae*) were placed for the overproduction and for the ordinary wine (*vinum de cupa*) such as the *deuterius* or *lora*, obtained after the third or fourth pressing and diluted with water. The wines obtained from the lees (*vinum faectum*) were also used for the inferior blends.

The preparation of the cooked juices with different degrees of concentration (*defrutum*, *carenum* and *sapa*) was carried out in the *cella defrutaria* (*cortinale*) and the smoked wines in the *fumarium*. All ancient types of wine could be produced in these facilities, including *dolia* for long aging, which were stored in large above-ground or underground (*cellae subterraneae*) cellars. These wineries could also have the space to dry grapes [45]. Alternatively, drying the berries could be done on the vine plant by twisting the stems [6,46], which is still practiced today.

- Egyptian wineries

The composition of Egyptian wineries from the Ptolemaic (332–30 BC) and Roman periods can be seen as an example of the simultaneous development of New Kingdom and rock facilities into large buildings necessary to meet the demand for wine, as described by Dzierzbicka [37]. The treading floor, often over 15 m^2 in size, had a height below the knee and bars above the head for holding with the hand during the process. Two channels led the juice through a wall into the collecting vat with a rectangular cross-section and over 30,000 L capacity. This vat was hewn into the rock or dug into the ground and plastered. The Ptolemaic documents do not attest to mechanical pressing, which was later carried out in the Roman period with a screw press in the corner of the treading floor. The fermentation took place in clay vessels that stood in a separate room on the floor. The pitching of these vessels was introduced in the Ptolemaic period. Interestingly, it was common practice in Egypt to age wine in amphorae for about 13 months under the sun in a room called the *heliasterion*, which probably had Greek influence. Unlike the Roman examples, there was no evidence of sunken vessels. The wineries were part of large rural settlements (*epoikia*) that belonged to wealthy private landowners and included other farms and kilns for the production of amphorae and bricks, making them comparable to Roman *villae* [37].

- The Levant wineries specialized for sun-dried grapes

The type of installation to process sun-dried grapes may be summarized using the numerous findings in Turkey [47], Jordan [48], and Israel [49] since the beginning of the present era. Dodd [4] evidenced the resemblance of processes between one winery of Antiochia ad Cragum (present Turkey) and six installations in the island of Delos (Greece) in different ambient of re-ruralized urban areas from the 4th to the 8th centuries AD, both apt to produce sweet wines from sun-dried grapes. In Antiochia, the facility was composed

of one floor for treading and pressing and a circular collecting vat under open-air or partially roofed. In Delos, treading was separated from the pressing floor, which was absent in some constructions, and the vats had squared sections. In both sites, the juice, probably partially fermented and would be transported to a storage cellar. Interestingly, Van Limbergen [46] described in northern Syria (4th–7th centuries AD) semi-open installations, where stone rollers were used to crush the dried grapes, explained by their harder texture. However, this strong crushing was not evidenced elsewhere and Palladius described, instead, the use of loosely woven baskets where grapes were beaten with rods before pressing [4].

Contemporary wineries in the Levant were more complex with a central treading floor, an intermediate vat, two collecting vats, and several auxiliary floors around the central one. These wineries were considered as the peak of the evolution from Byzantine until the early Islamic period [19,45,49]. The flow sequence from the basins to the vats enabled juice clarification and there was even a separation between the different pressed juices. The little juice that flowed from the grapes while they were drying would have been collected in small basins and directed into ceramic vessels to give the most valued wines. This was the *prototropum* or *mustum lixivium* as described by Columella or Pliny, somewhat equivalent to the present free-run juice.

The floors for drying could be placed over vaulted cells, showing the increasing complexity of these composite facilities [19,50–53]. These compartments were open facing to the central treading floor. All the system could work by gravity, with some pipes made of lead directed from the floors to the vats. Dray [52] posited that these upper floors could be used to obtain red wines by maceration. During the Roman and Byzantine periods, the wine was stored in ceramic jars and wooden barrels, placed in underground complexes hewn in the rock, aside the treading floors, or in large up ground roofed buildings (Vladimir Avrutis, pers. comm., 2020). The ubiquity of floors to obtain the *prototropum* juice and sun-dried grapes suggests that wine production in the Near East was specialized in producing expensive wines, probably stimulated by the visit of western European pilgrims to the Holy Land and subsequent exports [19].

2.4. Overall Categorisation of Ancient Wineries

The evolution in the typologies of ancient wineries is summarized in Table 1 and a schematic description is given in Figure 3. Overall, the last Roman and Byzantine wineries represent the final step of the continuous evolution of winemaking since Chalcolithic to Medieval times. This process lasted for thousands of years in the Mediterranean, reaching the Iberian Peninsula where rock-cut wineries with pressing systems have been found from the end of the seventh century BC [54,55] to Medieval times [56–58]. The winemaking approach was essentially the same since the first cave or rock-cut installations and could be broadly characterized by: (i) treading the grapes by foot; (ii) gathering the juice in a large basin or jar; (iii) pressing the pomace; (iv) finishing fermentation in clay vessels at storage facilities.

When wineries became a designed construction, the differences in wineries appeared to be related with climatic conditions. Wine presses in which the must is collected in large open collecting vats (*piscina*) were typical of regions where it does not rain in the summer months, such as the Southern Levant, Egypt, and North Africa [49]. In Western European regions such as Greece, France, and Italy, where there are considerable quantities of rain during the harvesting season, the common method in these regions was to allow the must to flow directly into ceramic vessels [45].

Table 1. Timeline and localization of ancient winery typologies (adapted from the categorization proposed by Avrutis [19] for Levant wineries).

Time Range	Epochs	Locations	Type	Main Features
4100 BC to 1300 BC	From the Late Chalcolithic to the late Bronze Age (BA)	South Caucasus, Cyprus, Greece, Turkey	Simple	Treading floors (1 or 2) and collecting vats (1 or 2) Most rock-cut Few free-standing built Possible press niches or bases since Iron Age Most near the vineyard Few in settlements (e.g., farmhouses, monasteries) Rare inside caves Possible storage in caves near the vats Wine storage in owner or ruler buildings
19th century BC to 8th century AD	Middle BA (Canaanite period), Iron Age (IA), Persian, Roman, and Byzantine to early Islamic periods	Levant		
8th century BC to 12th century AD	IA to Medieval times	Greece, Sardinia, Italy, Iberian Peninsula		
2575 BC to 1075 BC	From the Old to the New Kingdoms	Egypt		Elevated built treading floors and collecting *amphorae* Pressing by twisting bags *Amphorae* stored in roofed rooms
9th century BC to 8th century AD	Late IA, Phoenician, Persian, Hellenistic, early Roman, Byzantine, Early Islamic periods	South Caucasus, Levant	Improved	Like the simple type plus an intermediate vat between treading floor and collecting vat Rock-cut in the field or built-in housings Niche hewn in treading floor's wall for a press beam Few presses with stone screw base Frequent within settlements (e.g., farmhouse, domiciles, monasteries)
7th century BC to 12th century AD	Iron Age to Medieval times	Greece, Cyprus, Sardinia, Italy, Iberian Peninsula		Possible storage in caves near the vats Wine storage in owner or ruler buildings
6th century BC to 11th century AD	Hellenistic and Roman periods, peak during the Byzantine and early Islamic periods	Turkey, Jordan, Israel, Greece, Syria	Composite	Masonry open-air buildings with platforms to dry grapes Most complex facilities with with semi-circular vaulted compartments beneath upper floors Some with rectangular compartments in-between or in front of upper floors Ceramic or lead pipes, gutters to connect vats Fixed screw presses since Byzantine period Buildings in estates, villages, towns, monasteries *Amphorae* wine storage in independent roofed rooms
3rd century BC to 6th century AD	Ptolemaic to Roman periods	Egypt	Complete	Large treading floors with gutters to large collecting vats Screw presses in treading floors Open-air or partially roofed Open-air *amphorae* storage (*heliasterion*) Most in buildings in farmhouses (*epoikia*)
3rd century BC to 4th century AD	Graeco-Roman period	Western Europe		Treading floor, large collecting vats, screw presses Wine storage in *doliae* or in *cupae* *Doliae* under or on the ground in roofed or under the sun rooms Room for boiling or smoking juices/wines Typical buildings in farmhouses (*villae*)

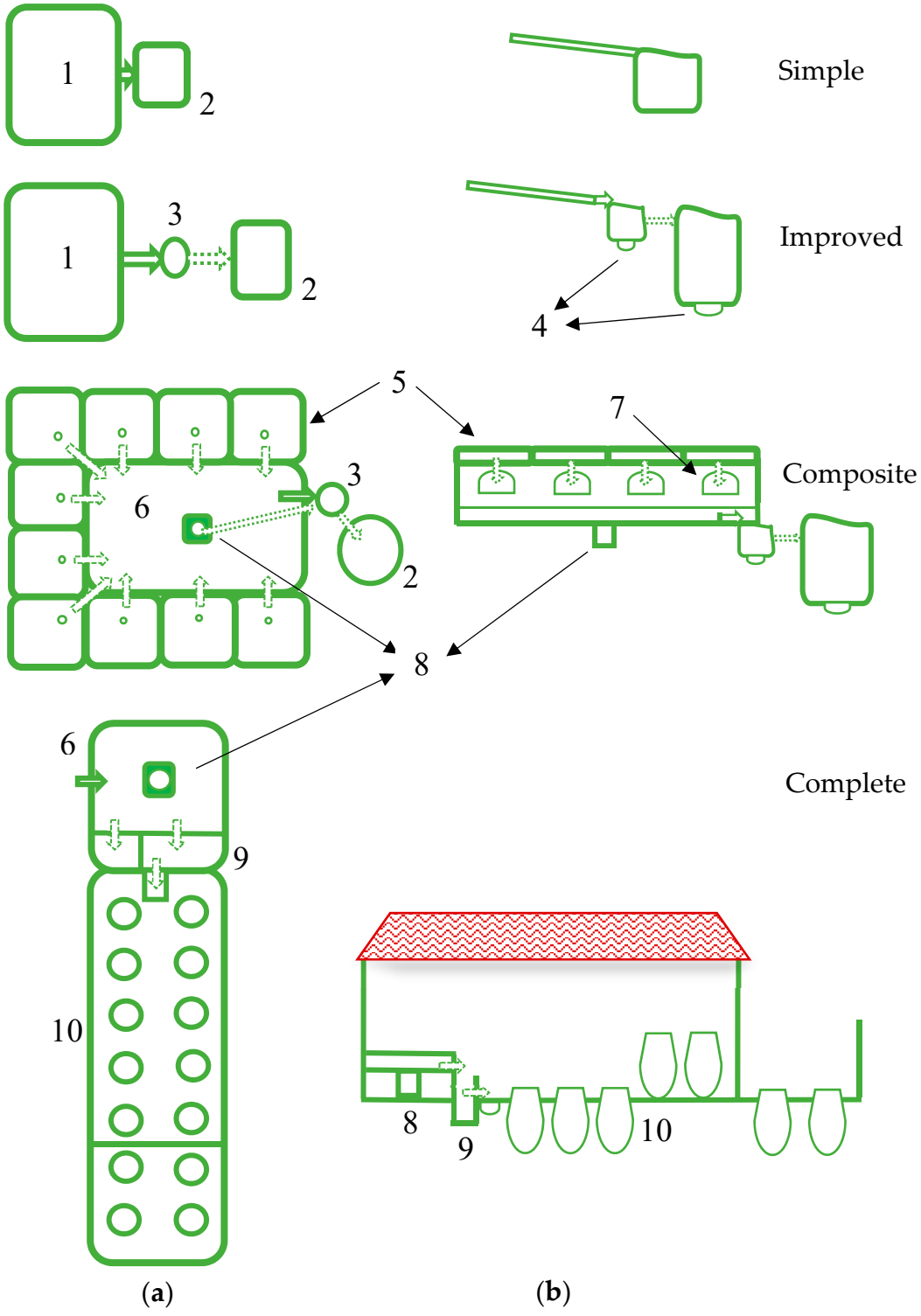

Figure 3. Schematic representation of the various structural typologies of wine production installations: (**a**), horizontal sections; (**b**) vertical sections) (1, treading floor; 2, juice collecting vat; 3, Intermediate vat; 4, sedimentation pits; 5, grape drying upper floors with holes; 6, treading and pressing floor (in separate sections or not); 7, vaulted compartments; 8, press base; 9, juice collecting vats; 10, clay vessels). Arrows indicate grape or juice flow (solid arrow, surface flow; dashed arrow, channeled flow).

3. The Ancient Wine Styles and Consumer Preferences

Wine consumption in antiquity was surely driven by its flavor properties, but it cannot be dissociated from its ritualistic [59] and medicinal properties [60] that are mostly not relevant today. Indeed, the most famous physicians, Hippocrates and Galen, distinguished wines according to their color (white, dark, straw-colored), their feeling on the palate or their consistency (thin/concentrated, light/full, hard/soft, smooth/sharp), their smell (odorous, with a honeyed smell, without smell), their sweetness (dry, semi-sweet, sweet), and their age (old, young) to prescribe them according to the patients' diseases [61].

The definition of wine styles and flavors is an exercise of speculation based on the interpretation of archaeological evidence, pictures, and ancient texts. Several authors have already addressed this issue in detail [5,6,43,62], but from a technical point of view, several questions have yet to be fully answered, although others seem to have obvious explanations, as described below.

3.1. The Ancient Wine-Making Process (AWP)

The fruity and floral flavor of modern wines is obtained by appropriate vinification at low temperatures and *élevage* minimizing oxygen contact. By the addition of sulphur dioxide and proper sealing, wines are kept under reduced oxygen concentrations conditions during fermentation, storage, and a long period after bottling. The overall process may be described as a reductive winemaking approach. On the other hand, oxidative vinification, not protected by sulphur dioxide and at ambient temperature, with air in vessel headspace during storage, provides another style of wine [63]. These oxidative wines do not have fruity/floral aromatic profiles and are those that should approximate the ancient flavor of dry styles the best. This does not mean that the wines were oxidized, which is an off-flavor, due to excessive oxygen levels conducing to acetaldehyde and other related metabolites. The difference may be difficult to perceive, mainly for those used to the present fruit-forward profiles, but it is essential to adequately evaluate ancient wine styles.

Contrary to oxidative winemaking, practically impossible to circumvent with the ancient available technology, other options were deliberate and easily stand out under the eyes of a contemporary winemaker. These options were mainly concerned with: (i) the caution given to the juice extraction leading to the apparent absence of crushing and destemming, (ii) the absence of skin maceration, and (iii) the secondary use of wooden barrels.

3.1.1. The Absence of Destemming and Crushing

Ancient texts and pictures do not evidence the removal of stems from the bunch. In today's practice, the stems have the function of facilitating juice extraction by pressing. Usually, it is not performed when vinifying without maceration, usually for white grapes. In antiquity, red or white grapes were handled by foot treading, so that the tannins from the stems were not extracted to the juice and would not influence noticeably the wine's astringency. Concerning sun-dried grapes, Pliny mentioned that "careful winemakers remove the stalks and soak the fruit in good quality wine until swollen before being pressed" [4]. This observation shows the awareness that stalks influenced wine characteristics if there was a maceration process, proving the infrequency of the operation.

Concerning grape mechanical crushing, early winemakers should have also been aware that the use of stone rollers would break seeds and increase wine's unpleasant astringency. The technology was at hand in comparison with ancient olive-oil extraction process, crushing olives in stone mills [44], but it does not seem to have been used, with the exception of sun-dried grapes in Israel and in Northern Syria [46,64]. In this case, heightened astringency would not matter because the output was wine where the sweetness masked the rougher mouthfeel perception [65]. If so, these wineries exemplify a technique specialization in a region with rather warm climate, particularly appropriate to produce sweet wines.

3.1.2. The Absence of Maceration

The question of the absence of maceration has been addressed by archaeologists puzzled with an option indispensable to make contemporary red wines. Frankel [44] hypothesized that some installations consisting only of ceramic vats without treading floors could be used to produce red wine with maceration, but they are not frequent. McGovern [3] (p. 90) mentioned that Old Kingdom Egyptian tomb depictions do not show the must to be siphoned off from the vat as it is later observed since 1550–1200 BC. The following New Kingdom scenes clearly show storage jars collecting the free-run juice, as it is also evident much later from the 3rd century AD Roman mosaics in the town of Cherchell (Algeria) or in Mérida (Spain) [66]. Avshalom-Gorni et al. [49] were aware of this question and pointed out that no ancient text describes grape maceration, positing that grapes and stems could be easily moved from the treading floor to the fermenting vat. However, archaeological reports do not elucidate the recovery of a large number of skins inside the clay vessels or masonry plastered basins. The difficulty in extracting skins from clay vessels buried in the ground may explain this technological option but this would not be difficult to do when large open basins were used. In our opinion, the effect of this process on wine style is marked in a way to be described thoroughly by classical texts just as the other processes were. In fact, Pliny, Columella, Cato, Varro, or Palladius described the sequence of several winemaking steps (e.g., pressing, juice separation, fermentation time) in detail, but made no reference to maceration [28].

Another issue to have in mind is the time required for maceration together with fermentation (about 6–7 days) that would occupy the treading floor for too much time, thus reducing the juice yield in each "winepress". The maceration was indeed used to obtain certain sweet wines after soaking dried destemmed grapes with wine, as mentioned by Pliny [4], or to obtain Coan wine (from the Greek island of Kos) by soaking sound destemmed grapes in seawater for three days, as described by Cato [37]. In addition, from a technical point of view, the little height of the treading floors (about 0.3–0.5 m) [4] would not enable proper maceration because the fermenting juice would push the cap (name given to the floating pomace) over the surface. The Portuguese "lagares", where the pomace is dragged by foot during fermentation, are filled until knee height and the wall is not lower than 0.80 m. Here, the objective of treading is to make the maceration and not to crush the grapes. In conclusion, the primitive wine installations did not appear to have been built, taking in consideration the use of maceration.

A possible alternative for maceration resulted from a reinterpretation of the winemaking process in the composite wineries of the Byzantine period (4th–7th centuries AD) by Dray [52]. This author posited that grapes were collected in an upper floor with holes that were closed to keep the juice together with skins. However, this option would reduce the productivity of these composite wineries at least by 50%, assuming a period of six days for fermentation and three days for sun-drying. The use of these costly composite wineries to produce cheap red wines does not seem likely, having in mind the high valorization of sweet wines. Nevertheless, it is possible that several types of wines could be produced.

3.1.3. The Use of Wooden Barrels

In today's wine world, it is almost unthinkable for many professionals to have high standard wines without oak aging in barriques. The purpose is to fasten the aging process and to provide attractive sweetish flavors and smooth mouthfeel. However, this was only acknowledged recently. During ancient times, pitched *dolia* were used for aging the best wines and wooden *cupae* for the least valued [43].

The expertise in building fine ships would have made it easy to assemble wooden staves to make a barrel, but this does not appear to have happened [3]. The introduction of oak barrels is usually attributed to the Celtic peoples when the Romans arrived in France [59]. However, the purpose should have been only to use a lighter vessel more resistant to storage and transport than clay jars and not to flavor and soften wine as it is envisaged today. A Minoan tripod cooking pot (*c.* 1900–1700 BC) was found with residues

of resinated wine and oak lactone, an indicator of addition of toasted oak [67]. However, this is an isolate finding given that there are no further references to the flavor effect of the oak, or other types of wood. In fact, the continuous use of barrels removes the odorants from the wood. Moreover, *dolia* were pitched and stoppered making a much more hygienic environment adequate for wine storage, only supplanted by aging in corked glass bottles after the 18th century AD [68]. On the contrary, barrels are much more prone to microbial spoilage due to their porous nature, which is still recognized today [69]. The problems with barrels' contaminations could be compensated by the better adaptation to wine transport. However, other explanations are possible, including a loss of taste refinement after the fall of the Roman Empire (27 BC–AD 476) [70].

In conclusion, the AWP may be broadly characterized by oxidative oenology, gently handling either grapes and juices, frequent sweet wine production, and a constant concern with off-flavor prevention, particularly during long aging. This winemaking concept appears to have lasted for thousands of years since the dawn of winemaking until the end of the Western Roman Empire and the Byzantine Empire in the Eastern Mediterranean basin, originating a wide diversity of wine styles adapted to Ancient consumer preferences. The onset of deliberate grape maceration is a question still to be answered.

4. The Diversity of Wine Styles

4.1. The Disregard for Full-Bodied Reds

Red wines, as understood today with deep red color, did not seem to have been particularly appreciated in antiquity. From a winemaker's perspective, it would be easy to conclude that the type of wine obtained by the AWP would be a rosé, or a claret, as primarily highlighted by Billiard [43]. Moreover, juices from red grapes fermented without skins, and in the absence of sulphur dioxide, quickly acquire a brownish color due to oxidative conditions. Then, assuming that maceration was not a common practice, it is necessary to give an explanation to the description, in classical texts, of different color depths. In some cases, the problem can be linked to the translation. Frankel [17] mentioned that Pliny distinguished white, brown, blood-red, and black wines, but this author adds that black may also be confounded with mustard color. Accordingly, the color *nigra* and *fusca* did not mean black, but deep brown due to exceptionally long aging [68]. Consequently, the translation of these color shades should not be done straightforwardly to red because old white wines have the same aspect, as exemplified today by the young ruby red Port wines that turn into tawny and ultimately have the same amber brownish color as aged white Ports.

When the color grading, as given by Columella, is doubtless (e.g., *sanguineum*, *purpureum*, or *niger*), Saltini [71] and Thurmond [6] concluded that these wines should have had some sort of maceration. However, other possibilities can be posited to obtain dark-colored reds:

(a) Adding dark fruits as described by Pliny and Palladius [62].
(b) Boiling juice for color concentration, like the modern thermovinification processes yielding deep red juices without maceration.
(c) Spontaneous fermentative short maceration of red grapes in treading floors, stimulated by high temperature.
(d) Utilization of varieties with high color intensity that give intense color to press juices without requiring maceration.

The last explanation can be inferred from the high color intensity of wild grapes [72] that could be found in the vicinity of the domesticated ones and could hybridize and give highly colored off-springs. This possibility is supported by two existing examples: (i) the Portuguese *Vinhão* (it means "big red") that is close to the wild ancestry [73]; (ii) the Italian *Colorino* that resulted from introgression of a wild ancestor [74]. There could be also a possibility of using grapes with red pulp (*teinturier*), but ancient texts do not describe these varieties [75] and still in present days are very rare.

Interestingly, the reference to skin color is not common in ancient varietal descriptions as if it was not an important quality factor [43]. Probably, red grapes were mostly light-

colored like the present Pinot Noir and other ancient Portuguese varietals (e.g., Rufete). The few Roman cultivars listed by Billiard [43] with clear indication of black-colored berries were considered of third quality grade and the worst among the six *Aminea* named varieties was black (*nigra* or *syriaca*).

Another relevant clue comes from the texts describing the therapeutical purposes of the different wines. Galen explained that black and thick wines are not easily digested and Athenaeus prescribed them only as a laxative [76], which are not exactly attributes of fine wines. The reason for the absence of maceration could also be of religious nature, dark wines being considered unfit for temple rituals in the Babylonian Talmud and claret wines being regarded as the best [17].

In conclusion, deep-colored red wines, as appreciated today, would be, at most, an exception and not a rule probably because of excessive astringency, strengthened by medicinal and religious reasons. If necessary, the mouthfeel softening of red wines could be obtained by: (i) the addition of juice concentrated by boiling [6]; (ii) leaving the wines to "mellow" by aging [77]; or (iii) adding egg-white [43], equivalent to the present oenological practices of adding concentrated grape juice, bottle aging or fining, respectively.

4.2. The High Status of White, Sweet, and Old Wines

The second question, which is also somewhat different from the contemporary preference for young fruit-forward wines (white or red), is the highest recognition of white, dry or sweet, old wines given in Antiquity [34,78]. Having in mind that *V. sylvestris* cultivars were mostly red [79], one reason might be the initial rarity of the grape color. The Egyptians may have been the first to produce white wines. Different tomb scenes show grapes in many sizes, shapes, and colors (from light green to almost black), and juices running from crushing vats and pressing sacks (ranging in color from light pink to dark red) [34]. Guasch-Jané et al. [35] claimed the first evidence of white wine in Tutankhamun's tomb due to the absence of syringic acid in the presence of tartaric acid in a considerable number of amphorae. These were placed together with others destined to red (probably claret) wine and to the most praised *Shedeh*, made with boiled grape juice, a practice illustrated in the tomb pictures. Likewise, the described Late Bronze Age Aphek winery (Israel's coastal plain) was most likely directed only to white wines or, at least, wines without maceration [20].

The highest quality was also associated with sweet wines originating from dried grapes (*vinum passum*) and was first described by the Greek poet Hesiod in the eighth century BC [78]. However, at much earlier times, the inhabitants of Ancient Anatolia (modern-day Turkey), the Hittites (1600–1200 BC), were already producing sweet "raisin wines" at the end of the Bronze Age [3,80]. Therefore, it is not surprising the abundance of the floors built to dry grapes in the warm areas of the Levant. Pliny mentioned the same type of sweet wines obtained from the *Apiana* variety either in Commandaria (Cyprus) or Cilicia (Turkey) or from *Psithia* variety (white and red grapes) that may both correspond to the present Muscat variety [4,76].

In Ancient Rome, sweetness could also be achieved by adding the *defrutum*, *sapa*, or honey [6] or by boiling grapes with olive oil [43]. These wines would also benefit from its ethanol content, higher than 16% (*v*/*v*), preventing spoiling by acetic acid bacteria and increasing the aging potential.

Indeed, the age was a primary valorization factor. Tchernia [68] explained that wines were considered old with more than one year after the vintage, but the optimum age for high quality was between 5 and 25 years. The recognition of old wines may be well explained by the fact that the amphorae inscriptions mentioned the vintage and the "bottling" years. The most expensive and luxury wine of Rome was the Falernian wine (from Falernum region), which had three types–*Austerum* (dry), *Dulce* (sweet), and *Tenue* (light), which could age well for dozens of years [68]. The sweet and dry Falernum would be amber in color and highly alcoholic [6]. It was made from the *Aminea* white grape variety [81], originated from Greece, and was first taken to southern Italy, where it was grown as *arbustum* and

yielded high quality wines, according to Pliny or Columella [75]. This author explains that *Aminea* might be the Greek *Byblinos* meaning "the vine that gets tangled up" well known by these Roman agronomists that also described the adaptation of the six *Aminean* varieties to different soils and training alternatives [43]. The *Aminea nigra* could well be used in blends yielding light red color that would turn brownish because of oxidative aging. Presently, in the Alentejo region of southern Portugal, *talha* wines made with white and red varietals develop a petrol-like color that justifies their denomination as "petroleiros" [82].

Regarding religious rituals, Frankel [17] mentioned that white wines were forbidden for the high priest in the Day of Atonement (Yom Kippur Day) probably because they were particularly intoxicating, but the description may also refer to effervescent white wines. For Christians, the traditional wine for Communion is white, probably because the dark red was regarded as wrong or sinful [56].

4.3. Unveiling the Flower-Scented Wines of Antiquity

The high-status wines could be acquired by aging under a veil, or pellicle of yeasts (the "flower"), and originate the most praised character of all wines. The evidence comes from a literary source, "The Life of Luxury" (*Hedypatheia*), from Archestratus of Gela, a Sicilian Greek author from the mid-fourth century BC [83]. He praised the white wine produced in the Aegean island of Lesbos [84]. Soares [84] describes his insightful appreciation of wines. The praised aged character was elicited by the evolution under a white film (compared by Archestratus to a grizzly hair embellished with white flowers) that can indicate nothing else, but a pellicle of *Saccharomyces cerevisiae* (former *S. beticus*) that develops even when ethanol is higher than 15% (*v*/*v*). Interestingly, these yeasts have been frequently isolated from Georgian white wines stored in clay vessels [15].

An analysis of other references to flower scented wines suggests that ancient authors were not mentioning the contemporary floral descriptors, but the flavors induced by flower yeasts, likely to be translated or interpreted as a fault [85]. Contrarily, Dalby [86] described the reference made by the choral poet Alcman from Ancient Sparta (*c.* 7th century BC), quoted by Athenaeus (2nd–3rd centuries AD), to a spartan flower-scented wine. Interestingly, this type of wine could have been boiled and seawater could have been added, under a recipe to produce *anthosmias* (flower smell) wine described by the Byzantine scholar Eustathius [86]. The boiling would concentrate sugar and raise the ethanol content, which today is known to stimulate veil formation by *S. cerevisiae*, while inhibiting acetic acid bacteria. Hence, the ancients found a way to have long-lasting wines enduring trade across the Mediterranean, to the Azov Sea (the northern extension of the Black Sea) or to Kabul [12].

Fernández [87] highlighted a few references to specific aroma descriptors named and described in ancient Greek tests. Hermippos, a comic author, used rose, violets and hyacinths as wine smells but this reference was not found elsewhere. On the contrary, apple smells were more often mentioned, consistent with the *anthosmias* wine and due to acetaldehyde formation. Then, when flower is mentioned, it should be related to veil yeasts. In fact, Collumela, Pliny and the *Geoponika* assume that wine with flower, since of white color, is very stable [87]. This author further quotes several ancient authors that praise *anthosmias* wine as a high-quality wine worth of being drunk by Dionysus.

Literary sources also mention that the highly praised Greek Thasos was an *anthosmias* wine [87], but did not elucidate if the Falernum, and other Roman famous wines appearing afterwards, could also be produced under a film of yeasts. However, Oribasius of Pergamon (*c.* AD 320–400), a contemporary Greek physician, prescribed Lesbos's wine as a fine wine [87]. The recipe of boiling juice and adding seawater was well-known and assuming that *dolia* could not be hermetically closed, it is possible that film yeasts developed easily and could be commonly present in wines of those times. Even today, the ullage in stainless steel vats is a critical step to prevent pellicle formation at the top of the wine. Probably, the iconic wines of Antiquity besides being white, sweet, and old were also flower scented.

4.4. Wine Flavouring

The addition of herbs and spices to wine with an oxidative profile would be the closest way to imagine the fragrance of ancient flavored, dry wines. The wide variety of appreciated flavors can be illustrated by the thorough study of chemical residues carried out in the clay jar remnants of a Middle Bronze Age (*c.* 1900–1600 BC) storing cellar [24]. The additives seem to have included resins as preservatives or as waterproof inner/exterior coatings (e.g., storax and terebinth resins), sweeteners (e.g., honey), drugs (e.g., cedar oil), and flavorings (e.g., cyperus, juniper, mint, myrtle, cinnamon), most of which were attested in the 18th century BC Mari texts from Mesopotamia and the 15th century BC Ebers Papyrus from Egypt. These additives suggest a sophisticated understanding by the Canaanites of the pharmacopeic skills necessary to produce a complex beverage that balanced preservation, palatability, therapeutical, and psychoactivity effects [24]. Interestingly, each jar contained different proportions of the additives, indicating different recipes, probably to obtain different flavor or medicinal effects. Sequential excavations evidenced larger sunken pithoi (100 L) in other rooms that perhaps functioned as a blending facility to prepare wines according to the favorite flavors [88].

In Rome, additional processes could be applied to increase pleasant flavors by adding a wide range of herbs, herbal blends, flowers, or spices to wines, properly named as *vinum ficticia* [43]. Typically, these alternatives were a copy of the Greek diluted wines used at the *symposium* or its equivalent at the Roman *convivium* sessions, accompanied by music or dancing [89]. Interestingly, for the Greeks and Romans, the civilized way of drinking wine was, in fact, to dilute it with copious quantities of water to make it more palatable, whereas strong or "unmixed" wines were intended for the "undisciplined, uneducated barbarians" and gods [5,90]. The Roman *mulsum* was mixed with honey and spices, resembling the present sweet Madeira, while others (*turriculae*) had salt or even seawater, like the Greek wines from Chios and Cos [5]. Smoked wines were another type of flavored wine, but were not appreciated by Pliny [70].

The present chemical characterization of the ancient herbs and spices shows the presence of molecules that may have contributed to the flavor of wines. For instance, the storax resin has ethyl cinnamate, characterized by aroma of white flowers in *Fiano* wines [91]. The effect of the right concentrations of these flavor molecules could probably yield a product mimicking the flavor freshness of the actual fruit-forward wines.

Likewise, the addition of fenugreek was commonly used to fake the flavor of expensive old wines [5]. This herb is rich in sotolon, a chemical molecule with nut and curry descriptors, which has been detected in aged wines like the sweet *Madeira* or the dry *Chardonnay*. During oxidative aging, aldehydes' concentration first rises by chemical or microbial biosynthesis further leading to sotolon production in a process independent from yeast metabolism [92].

Despite the common practices of flavoring wine, limitations to wine manipulation were also observed regarding religious restrictions. Frankel [17] mentions that the spiced wine was considered unfit for the Temple in Talmudic and Hebrew rules, while water-diluted wine could be used [17]. Interestingly, the wine used in present Orthodox and Catholic Eucharistic celebrations must be pure, mixed with a small portion of water and served with leavened or unleavened bread [93]. On the contrary, the Armenian Apostolic Holy Church uses only "unmixed" (undiluted) or pure grape wine for the Lord's Supper or the Holy Eucharist [94].

4.5. The Requirement for Flawless Wines

In ancient times, wine quality was undissociated from its use as medicine and so healthy wine meant free of off-flavors. Therefore, the best Greek winemakers were also physicians as noted by Pliny [62] and should have been very sensitive because they recognized many of the actual flaws [43]. Probably, the only off-flavor presently significant and not acknowledged at that time was related with the reduction processes (e.g., the smell of rotten eggs) given the oxidative winemaking.

Billiard [43] and Thurmond [6] described a wide variety of stabilization techniques that are still common oenological practices (e.g., filtration, decantation, fining), including a sort of pasteurization by placing the vessels on the rooftops to heat them under the hot summer sun, an option still practiced in some *Madeira* styles. In Egypt, amphorae were left at ground level under the sun [37].

In addition to these physical processes, prevention of spoilage was also obtained with the use of resins extracted from terebinth, pine, cedar frankincense, or myrrh trees, as enumerated by Pliny the Elder and Columella [3]. The precursor of the most efficient wine preservative, both antimicrobial and antioxidant, sulphur dioxide (SO_2), may have been obtained by burning sulphur. It appears to have been developed first by the Egyptians and later by the Romans [95] and employed by the Urartians [14]. Tchernia and Brun [5] stated that Pliny preferred resins to sulphur. Remarkably, one of the main constituents of terebinth and frankincense resins is α-pinene, a terpene with antimicrobial activity that has just been tested as an alternative to sulphur dioxide either preventing bacterial growth or color browning [96].

These resins had also flavor and medicinal activities, being used by different peoples depending on their regional availability. The present resinated wines may be regarded as their descendants and are limited to the Greek *retsina* [3]. Interestingly, Columella mentions that high quality wines age well, do not require any supplement, and that the work begins in the vineyard by harvesting sound grapes in the right ripening date [43,71].

Burning sulphur to preserve wine was not known by the Greeks who used gypsum (calcium sulphate) and seawater or salt, as described by Theoprastus [62]. The practice of adding seawater was so common that the wines were known as Greek wines (*vinum graecum*) and the recipe was explained by Cato [6,37]. It is not clear how the amount of salt could act as a preservative, since it is not allowed today.

The question of vessel ullage is also relevant when wines are stored in *dolia* stoppered with clay *operculae* [43] or with cork covered with *pouzzolan* [68]. In Egypt, there are references to olive oil addition to cover the wine [37], a practice still used in clay vessels (*c.* 1000 L) in Portugal's Alentejo region. After fermentation, and in the absence of carbon dioxide, a film of undesirable yeasts or bacteria may develop, oxidizing the wines and leading further to acetification if the jar is not well closed. The prevention was obtained by pitching the *pithoi* and adding plants on the top before closing it with baked earth after fermentation [62]. However, Greeks and Romans understood that some of these films were detrimental, while others were beneficial depending on the color [43,62,85,87], as mentioned before for the *anthosmias* sherry-like wine.

5. Ranking Wine Quality, Origin Denomination, and Consumer Segmentation

The information retrieved from ancient texts shows that wines were known according to their origin, valued according to their quality, and consumed in different contexts [5]. The first textual cuneiform references from the Babylonian city of Mari (1800 BC) ranked wines according to their quality and corresponding consumer social status. The best wines, under the King's control, were reserved to high officials, while the red "thick and bitter" ones were the least valued and directed to the lowest rankings of society [97], which is in accordance with the previous comments to the ancient disregard for these wines. The first written evidence that occurred on Linear B clay tablets (ideograms for wine) about the qualities of wine comes from the Mycenaean administrative documents from the Bronze Age (*c.* 1375–1200 BC) palaces on the island of Crete (palace at Knossos) and on the mainland of Greece (palace at Pylos), probably with mutual influences from contemporary pharaonic Egypt. In both sites, the wines were rated as "genuine", "very good", and "good" [98].

The description of numerous wine types in classical texts demonstrates the ability to discern their differences and respective consumption occasions, including food pairing. Archestratus of Gela is regarded as the first European gastronomic critic authoring a guide of the most exquisite foods of the time [83,84]. He made a judicious comparison between

the mentioned Lesbos wine and the *Bybline* one from the town of Byblos in Phoenicia [84]. Dalby [83] warns that the *Bybline* may well be from other regions or even a wine from *arbustum* vines [75], but the case here is to observe the expertise of the author. Archestratus says: "if you do not know it, the first time you taste it you may think better than that from Lesbos, but if you continue drinking you will find it much inferior" [84]. Just like the present attractive wines of international commercial style that have both no flavor persistence and a deceiving finish [99]. Archestratus understands that wine changes during consumption and continues to criticize those who mock the Lesbos quality and others who only praise the goods of their region [84], anticipating what is now described as ethnocentrism or neophobia [100]. These comments clearly illustrate the high standards and elitism of the ancient *gourmands*.

The rise and fall of the Greek wines in Rome are a good example of the consumer trends at various social strata. Komar [77] associated the fame of Chios, Cos, Lesbos, and Thasos wines to the reverence of Greek culture by the Roman aristocracy since the third century BC. These were considered luxury and exotic products, which started to lose value with increasing consumption by citizens with rising economic power. The Aegean *crus* became mass beverages and elites began to produce their own wines, and from the first century BC onwards, Falernian, Caecuban and Albanian wines replaced the Greek ones. The fame of Cos and Chios was also damaged by the falsification to supply wines for consumers that could not afford a Falernum [101].

These denominations reflect the association of wine quality to the origin since the first inscriptions in Egyptian amphorae reporting vineyard localization [3]. The state-regulated control over the Thasian wine trade could be seen as the first ancient legislation directed to the Protection of Appellations of Origin (5th century BC) that included clay stamps on one and/or two-handled ceramic amphorae [12]. Another type of denomination could come from the port, where the wines were shipped. In the case of Malvoisie (from the Greek port of Monemvasia), it turned to be the name of a diverse group of genetically unrelated grape varieties.

The ordinary table wines were the most common in Rome. The cheapest were diluted with water either at fermentation (*lora* or *vinum operarium*) or after (*posca*) and were abundantly distributed and consumed among the lower ranks of society and the military, respectively [5]. According to the recipes of the Byzantine Greek physicians Aëtius of Amida and Paul of Aegina (6th–7th centuries AD), the watered-down *posca* was mixed with various flavoring herbs and spices (e.g., cumin, fennel and celery seeds, thyme, anise, etc.) and used as a laxative [102]. Another popular wine was the *vappa*, which Pliny described as being flawed and demanding a quick sale [68].

6. The Archetypes of the Present Wines: Similarities and Differences

The previous analysis of the ancient wine styles showed a remarkable resemblance with the present ones. Moreover, several of the recent market trends may find their archetypes in some of the ancient wines' styles, as summarized in Table 2.

Concerning age, the most valorized wines continue to be those with the highest aging ability. Probably the main difference concerns the present value given to red wines from reputed regions like Burgundy or Bordeaux. The recognition of old white dry wines is a different matter, while preferred by connoisseurs, other wine professionals differently educated seem to consider them as oxidized and of lower quality when compared with fruit-forward young wines [103].

Table 2. Types of ancient or classical wines with salient sensory features and respective historical background.

Popular Denomination	Salient Sensory Cues and Historical Examples	Illustrative References
Aged red fine wines (*vin de garde*)	Light red colour with yellow/brownish hue, metallic flavour, sourness, aging bouquet without fruitiness, and wrongly associated to oxidation	[104]
	Ancient and classical aged light red wines fermented with little or without skin maceration	[3]
Aged white fine wines (*vin de garde*)	Yellow straw colour with brownish hue, sourness, saltiness, aging bouquet without fruitiness, and wrongly associated to oxidation	[99,105]
	Ancestral Greek and Roman old white wines, classical aged white wines	[5,63]
Aged sweet fine wines	Amber colours, nutty flavours, overt sweetness, occasional ethyl acetate	[106,107]
	Ancestral Greek and Roman sweet wines from withered grapes	[78,108]
White wines with grape maceration (e.g., clay jar, orange wines)	Dark yellow or amber colour, oxidative flavour, astringency, and bitterness	[109,110]
	Ancestral winemaking technique with present global dissemination	[16]
Umami wines	Yellow colour, oxidative Sherry type flavours, saltiness	[111]
	Ancestral Greek clay jar wines aged under a pellicle of yeasts	[12]
Pet Nat wines (*Pétillant Naturel)*	Little effervescence and turbidity	[112]
	Ancestral effervescent wines	[113]
Blurred, mulled, fruit or herbal wines, *sangria*	Vegetal or sweetish flavours, vermouth style flavours, bitterness	[114,115]
	Ancestral Greek and Roman wines with addition of flowers, fruits, honey, or concentrated grape juices, present mixed wines with other beverages	[3,5]
Organic, natural, life-style or sulphite-free wines, *piquettes*	Occasional off-flavours, relatively frequent mousiness, low ethanol	[116]
	Ancestral popular wines without preservation capacity (*posca* and *lora*)	[5]

The value of old wines is especially visible in sweet wines, most of them now fortified as those from Port, Madeira, Sherry, or Marsala denominations. The fortification only became an alternative to the sweet wines from dehydrated grapes after the dissemination of stills in the XIV century by Dutch distillers. However, these naturally sweet wines have not disappeared, but continue to have a wide diversity of descendants all over the Mediterranean. Examples are the Italian *passito* or *vin santo*, the Spanish *vino de pasas* and the French *vin de paille*. Probably, the sweet variants corresponding to ice wines and botrytized wines (e.g., *Tokaji*, *Sauternes*) were the single ones that did not exist in Antiquity. Indeed, Van Limbergen [46] emphasized the attention given to discard rotten grapes during the drying process, which indicates that it would be unlikely to find the predecessors of sweet wines, obtained from noble rot grapes in antiquity. However, it is possible that the wine *saprias* from Chios was obtained from rotten grapes [98]. Overall, modern sweet wines (natural or fortified, young or old) continue to be among the most valorized by worldwide consumers, being a case where the differences from Antiquity should only be related to the technological evolution given their common oxidative aging. The exceptions are related with the use of bottle aging, favoring reductive processes like in vintage ports.

The most well-known present successors of the *anthosmias* wines are the *Jerez* and *Manzanilla* (Spain), *vin jaune du Jura* (France) and *Vernaccia di Oristano* (Sardinia) [111], which have dry to sweet variants, fortified or not. The popular wine press coined this style as umami wines, given their deliciousness (i.e., umami means delicious in Japanese). Interestingly, these wines are mostly white and, besides have typical bruised apple flavors, elicit a saltiness perception common to present old fine wines irrespective of the mode of production.

The praised bubbling effect of dissolved carbon dioxide in sparkling wines was also recognized in Antiquity. Herodotus (5th century BC) and Strabo (1st century BC)

described the "fizzing and sweet-as-honey wine of Colchis", region on the Black Sea coast of Georgia [113]. The popular "Vinho Verde" from northern Portugal may be regarded as a direct descendant of these wines [16]. The appearance of modern carbonated or sparkling wines was only possible in the 18th century when glass bottles became resistant enough to stand the high carbon dioxide pressure. The trendy *Pétillant Naturel* (Pét Nat) wines with perceived cloudiness due to the absence of yeast removal may also be regarded as an update of those wines.

The addition of flavors was common in antiquity and is recognized as the key to commercial success. This practice is only allowed when the label clearly states that the beverage has added flavors, like the modern vermouths or mulled wines [117]. However, technological options like fermenting at low temperatures, use of enzymes to hydrolyze aroma precursors, aromatic yeasts and widespread use of oak barrels and derivatives fill the same purpose of increasing fruity and floral flavors that are the most commercially attractive [118].

The acceptance of off-flavors in antiquity should have been a matter of necessity for the less fortunate. Wine dilution with water would reduce vinegary flavors and its inebriating effect. The actual representatives include the beverages known as "piquette" in France and "água-pé" in Portugal, which were traditionally given to farm and vineyards workers. On the contrary, today wine flaws are accepted by highly educated tasters because constitute the cue for organic wine recognition [116]. Moreover, the so-called life-style wines with less ethanol are directed to meet the requirement for low calorie beverages among consumers concerned with health issues.

In conclusion, the most significant difference between ancient and present wines appears to lie precisely in the lowest quality range. Contemporary mass-produced commercial wines are free of off-flavors and offer consistent quality at an affordable price to a large part of the consumers. Probably, the so-called fine wines [119], either old or sweet, were not so different from the present ones, as it might be envisaged given the remarkable technological evolution in wine science and technology.

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