

Umami and the foods of classical antiquity^{1–3}

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ABSTRACT

Umami is the taste of foods that are rich in glutamic acid and 2 ribonucleotides, 5'-inosinate and 5'-guanylate. This distinctive taste of modern Eastern cuisine, which is finding a receptive audience in the Western hemisphere, characterized many dishes that ancient Romans consumed >2000 y ago. Romans enjoyed numerous foods that are identified today as containing significant amounts of natural umami substances and frequently used fish sauce as a condiment in their recipes. Fish sauce imparted to Roman dishes a moderately salty, slightly fishy taste that combines synergistically with other foods to create the umami flavor. Fish sauce derives from the hydrolysis of fish in the presence of salt primarily through endogenous enzymic proteolysis. Its simple production process, low cost, and ability to enhance the taste of many foods has made it the basic condiment for traditional dishes consumed in many Southeast Asian countries. Fish sauce also has important nutritional value, primarily in the form of amino acids. Because ancient Romans made fish sauce in the same way and with the same resources as modern fish sauce producers of Southeast Asia, the amino acid profiles of the 2 products are probably nearly identical. Archaeological sources indicate that fish-processing centers operated throughout the Mediterranean area, and processed fish was an important element in long-distance trade. A close study of the remains of the Roman city of Pompeii indicates that fish sauce was a thriving business that rendered the popular condiment accessible to people of all social classes. *Am J Clin Nutr* 2009;90(suppl):712S–8S.

INTRODUCTION

Umami is the typical taste of Eastern cuisine that is again beginning to find a receptive audience in the Western hemisphere; it was apparently the taste that defined much of the cuisine of the ancient Roman world >2000 y ago. Umami denotes the taste of foods rich in glutamic acid and 2 ribonucleotides, 5'-inosinate and 5'-guanylate. These substances occur naturally in various meats, fruit, vegetables, and certain processed foods, such as cheese, fish sauce, and soy sauce (1–5). Although Romans did not have all of the foods we enjoy today, including tomatoes and spinach, they did consume many of the foods identified today as containing significant amounts of natural umami substances (6). These include vegetables such as carrots, mushrooms, cabbage, asparagus, peas, and onions and such fruits as grapes and apples. Pork and chicken were favorite meats, although Romans also ate beef. Seafood included sardines, mackerel, tuna, oysters, and prawns. Our knowledge of these ancient Roman umami foods comes from literary, art-historical, and archaeological sources.

Food was a popular motif in the decoration of Roman houses, especially in rooms associated with preparation or consumption of food, such as kitchens and dining rooms. Umami foods depicted in wall paintings and floor mosaics include grapes, apples, asparagus, pig, chicken, and fish. Scientific analysis of pollen, carbonized fruit and vegetables, and animal bones found at archaeological sites adds many other foods to the list (7–10). This physical evidence provides confirmation of available foods, often affirming what we learn from Roman agricultural writers. The art-historical and archaeological material does not, however, tell us much about how Romans prepared these foods. For that we must consult the literary sources.

Satire, a genre noted for its use of the meal as a vehicle to criticize society's foibles, often identifies the kinds of foods eaten at specific meals. Usually with some exaggeration, it describes those foods that were particularly noteworthy (11). Pliny the Elder, in his encyclopedia *Historia Naturalis*, gastronomic authors such as Athenaeus in his *Deipnosophistae* (Philosopher's Banquet), and medical writers who discuss dietetics provide more evidence about available foods and occasionally instruction on how to prepare the dishes (12–14). Our best source, however, is the cookbook attributed to Apicius (15). It is the only cookbook surviving from the Roman world, and contains ≈465 recipes, with whole chapters devoted to dishes prepared with vegetables, pulses, birds, quadrupeds, and sea animals. These recipes allow us to get closer to the Roman diet but still tell us little about how these dishes tasted.

Today, many practical food historians, consulting ancient recipes and modern cooking methods, and by using intuition, attempt to reproduce the flavors of Roman food (16–18). Because instructions found in the ancient recipes often lack detail and are ambiguous or incomplete, and because some ingredients, such as silphium, are no longer extant or are difficult to obtain, we can never be sure if we have replicated exactly the taste of Roman food. Nevertheless, most of these “re-created” dishes probably come close to their ancient predecessors, because the primary condiment used in Roman recipes is fish sauce, the well-known ingredient in many traditional foods of modern Southeast Asia.

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The flavor of ancient Roman cuisine, therefore, derived from the frequent use of umami substances found in fish sauce.

ROMAN FISH SAUCES

Romans had 4 different fish sauces: *garum*, *liquamen*, *allec*, and *muria* (19). *Garum* was the primary sauce produced by the hydrolysis of small whole fish or fish innards in the presence of salt through natural fermentation over several months (**Figure 1**). The undissolved fish material remaining from *garum* production was called *allec*. *Muria* was the salty solution that resulted from osmosis during the salting of whole, gutted fish or slices of fish meat (*salsamentum*). The precise nature of *liquamen* remains obscure, but, based on modern parallels, it seems to have been the result of subsequent washings of *allec* with a salty solution. As such, *liquamen* was closely related to *garum*, and its similar production process explains why in late antiquity the term *liquamen* effectively replaced *garum* as the generic word for fish sauce.

Ancient literary sources provide few details of the production processes for fish sauces (19). In general, Romans placed into a vat small fish, particularly anchovies, sardines, and mackerel, and added salt at prescribed ratios and sometimes various herbs, spices, or wine. They used weights to press down on the concoction, covered it, and allowed it to remain in the sun for several months. At the end of this time, they withdrew the liquid *garum* by using a basket, filtered it, and placed it in a terracotta transport vessel, or amphora. This description, sparse though it is, bears a marked similarity to the production processes for modern fish sauces of Southeast Asia.

Traditional processing methods can vary between countries, and even within a country, but the essential outline is common to

all (20). Producers place into a terracotta vessel, barrel, or concrete vat small, whole fish, usually anchovies, and mix the fish with salt in a specified ratio that can vary but is usually $\leq 5:1$. They then place weights on the mixture, cover the vat, and allow fermentation to continue for up to a year or more. They then remove the liquid sauce by ladling or draining from a conduit at the bottom of the vat. Once filtered, they place the sauce into bottles. They often wash the residue with a hot, salty liquid and allow it to ferment before extracting a second-quality sauce. This simple inexpensive method produces a condiment that greatly enhances the taste of food, and it has made fish sauce the basic condiment for traditional dishes consumed by Southeast Asians.

Clearly, Roman fish sauces, both in basic ingredients (fish and salt) and in production methods, parallel almost exactly the traditional fish sauces of Southeast Asia (**Figure 1**). Because ancient sauces have not survived (except for the dried remains of *allec*), their appearance, taste, and smell can best be surmised by an analysis of modern Southeast Asian fish sauces, such as *nam-pla* of Thailand, *nuoc-mam* of Vietnam, and *patis* of the Philippines.

MODERN FISH SAUCES

In biochemical terms, modern sauces generally are clear filtered liquids that are prepared from solutions of $>20\%$ salt and whole, unviscerated, usually pelagic fish, especially anchovies. The fish undergo a slow process of autolysis through the action of endogenous proteolytic enzymes derived primarily from the stomach and digestive tract (21–23). Enzymes such as trypsin and pepsin attack fish tissues, whereas salt removes moisture by osmosis. The proteolytic activity of these enzymes varies with fish species, and in some species according to the season of the

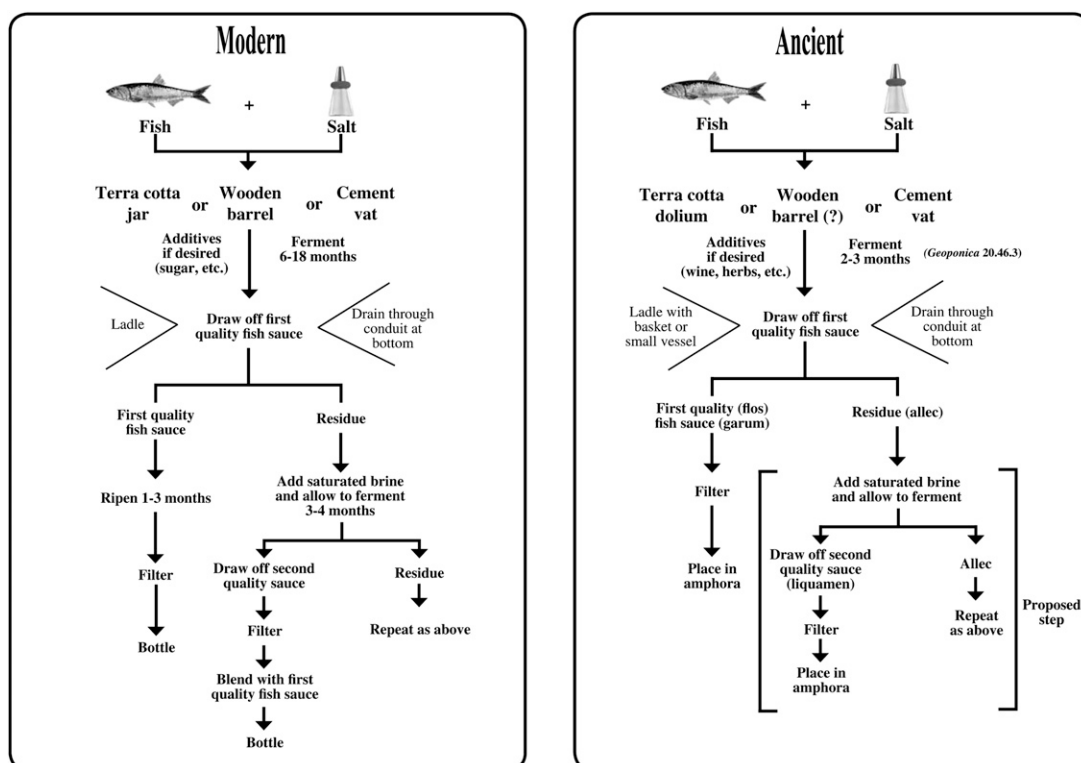


FIGURE 1. Flowchart showing the production process for modern and ancient fish sauce.

year, but generally is quite low. As a consequence, the process can take a considerable amount of time (24). Eventually, the fish loses its shape and begins to liquefy as proteins decompose into amino-nitrogen compounds, notably amino acids, oligopeptides, and nitrogenous bases. Because enzymic hydrolysis is not total, an insoluble residue remains.

The quality of the final product depends on limiting the growth of microorganisms. The best fish sauces contain few bacteria, except for those that appear between catch and the initial stages of processing. When it occurs, bacterial spoilage raises the ratio of biogenic amines to amino acids and creates a stronger smelling sauce which is considered to be of poorer quality. The better-quality sauces do not constitute a health hazard, because a fish-to-salt ratio of $\leq 5:1$ and a relatively low pH of 5.0–6.5, common in the best fish sauces, are not conducive to the growth of bacteria. This reduces the likelihood of putrefaction and minimizes the chance of botulism poisoning. In effect, the resulting product is neither rotten nor dangerous to consume (25).

Scientific analysis also reveals that fish sauce has important nutritional value, providing the inhabitants of Thailand and Vietnam with a useful source of amino acids and many micronutrients, such as vitamin B-12 (24). Fish sauce contains ≈ 10 g amino acids/100 mL, mostly in the free form ($\approx 70\%$). The amino acid profile roughly parallels that of fish protein and thus contains significant concentrations of essential (as well as nonessential) amino acids. It has been estimated that the ingestion of 15–30 mL fish sauce/d could provide $\leq 7.5\%$ of the daily dietary protein intake of the inhabitants of Vietnam, and thus supply amino acids (eg, lysine) that are deficient in the cereal grains common to the Vietnamese diet (24). The amino acid content and profile of ancient fish sauces are unknown, but the close parallel to their modern counterparts in ingredients and production methods strongly suggests that ancient and modern amino acid profiles are similar. Currently, the Ajinomoto research laboratories (Tokyo, Japan) are examining samples of the Roman fish sauce allec from first-century AD Pompeii to determine their amino acid compositions, where possible.

Scientists characterize the taste of modern sauces as a blend of ammoniacal, meaty, and cheesy and attribute this to a combination of active taste components, such as volatile fatty acids and ketones, and particularly amino acids. The dominant free amino acid in fish sauce is glutamate, which is present at a concentration of ≈ 1300 mg/100 mL fish sauce. As such, it has one of the highest free glutamate contents of any food, similar to that of parmesan cheese, which has a marked umami taste (3, 26–28). Fish sauce, used as a condiment, therefore adds to foods the tastes of both salt and umami, which produces a distinctly savory flavor that is actually a combination of taste and smell (4, 29–31). Two thousand years ago, it was apparently the dominant taste enjoyed by Romans, who used fish sauces often and in many of the ways inhabitants of Southeast Asia use them today.

ROMAN WRITINGS ABOUT FISH SAUCE

Much of our evidence about ancient fish sauce comes from writers; these writers belonged to an elite social strata that apparently had a love-hate relation with the condiment. For example, in one of his many moral letters, L. Annianus Seneca, a close advisor to the Roman emperor Nero and a noted Stoic philos-

opher, bemoans his society's lack of interest in philosophy and derides the widespread popularity of excessive consumption. Among critical comments on mushrooms, oysters, snow, and what he describes as other "purulent" foods, he sputters: "Don't you know that 'Garum Sociorum,' the expensive bloody mass of bad fish, consumes the stomach with its salty rottenness?" (32). Pliny the Elder, whose first-century AD natural history encyclopedia influenced scientists for >1500 y, calls garum "that secretion of putrefying matter" (33). Putrefaction, with its concomitant associations of foul smell, strong taste, and revolting appearance, was a favorite allusion among Roman literary writers commenting on fish sauce. The characteristics of fish sauce also provided satirists with a vehicle for personal abuse or social commentary. For example, to allude to a person as one "who wipes his nose on his shirt sleeve" was enough to identify him as a producer or seller of processed fish (34). So persistent has this pejorative portrayal of fish sauce been over the centuries, that even in the middle of the 20th century, a noted ancient historian concluded that "Our stomachs would probably revolt at a dish prepared with garum" (35).

The press for Roman fish sauce was not all bad. The satirist Martial calls garum "noble" and even devotes an entire epigram in praise of "Garum Sociorum," the same sauce that Seneca had lambasted (36). Pliny the Elder, who had noted garum's likeness to putrefaction in another place claims that it could be diluted to the color of honey wine and drunk (33). Most likely, Pliny was not actually suggesting that anyone do this; he merely states that a diluted form could be drunk. Such "positive" literary portrayals have led many scholars to argue that fish sauce was an expensive food item reserved for the upper class. One modern commentator (Charles Feldman) postulates that its popularity derived primarily from a social motivation that guided culinary tastes (37, 38). The more expensive and exotic the food, he argues, the more cachet it had and the greater social capital achieved by being seen to eat it. The very characteristics the ancients ascribe to fish sauce—foul smell, strong taste, bizarre production process—also qualify it as "exotic" by today's Western standards. Those who see fish sauce as a popular food confined to the Roman elite point to this literary depiction as evidence, especially the famous cookbook by Apicius. Of 465 recipes recorded in Apicius' cookbook, $>75\%$ include a fish sauce. Although Apicius was a noted gourmand of the first century AD, the cookbook attributed to him is now characterized as a collection of recipes compiled over several centuries and was written primarily for the tables of the wealthy. But was fish sauce the exclusive reserve of the aristocracy? Ample evidence exists to suggest that, like its counterparts in Southeast Asia, it was not.

The most recent view of Apicius' cookbook, based on a close look at its Latinity, regards it not as a recipe book composed predominantly of exotic and expensive dishes but rather as a compilation of recipes written by real cooks whose social status was probably servile or former slave (39). In addition, archaeological investigation, particularly over the last half century in the Western Mediterranean, has uncovered evidence for the widespread production and commerce of fish sauce throughout the Roman Empire. And, the view that Romans of all social strata had easy access to fish sauce and used it regularly in their daily lives draws strong support from excavations in the city of Pompeii, destroyed by Mt Vesuvius in AD 79.

ARCHAEOLOGICAL FINDS OF FISH SAUCE PRODUCTION AND TRANSPORT

Archaeological excavations have uncovered numerous remains of large and small fish-salting installations, dating between the second century BC and sixth century AD, which dotted the Atlantic and Mediterranean coasts along the seasonal migration route of tuna (19). The best-documented areas are in Spain, Portugal, France, and North Africa in the Western Roman Empire, and in the Black Sea in the Crimea and the Strait of Kertch (19, 40, 41). Over 60 fish-processing sites have been confirmed in Spain and Portugal alone, including large centers at Troia, which had a production capacity that exceeded 600 m³. But this site pales in comparison to salting installations at Lixus in Morocco, which had a capacity of >1000 m³ fish sauce (42). Many other sites receive mention in literary sources, whereas others have been recognized only from characteristic physical evidence.

Signs of a salting installation include, most prominently, salting vats (*cetariae*) (**Figure 2**). They are usually square or rectangular in shape and vary in size and depth. The 10 vats comprising Factory 5 at Baelo, for example, average 1.60 × 1.76 × 1.68 m, with an average capacity of 4.73 m³ (42). During the annual migration of tuna between the Atlantic Ocean and Mediterranean Sea, large vats accommodated fish meat for salt fish, whereas smaller ones held viscera for fish sauce. When the tuna had passed, installations probably concentrated on smaller fish that were more readily accessible, such as sardines and anchovy, the fish most often used in modern Southeast Asian fish sauce factories. Romans placed the processed fish products into amphorae and transported them to markets throughout the Roman Empire.

Many cargoes of fish sauce amphorae made it to their destinations; others ended up on the sea floor. Plotting shipwrecks that contain fish sauce vessels provides a graphic view of the usual sea routes followed by merchant ships. For example, such evidence indicates that a primary trade route between Spain and Italy ran from Spain northward along the Mediterranean coast to the mouth of the Rhone River (43). From there, ships headed east where the shipping lane split into 2 routes. One route went north of Corsica, the other between Corsica and Sardinia. From there, ships could reach Rome, the Bay of Naples, and points east

(Spanish salt fish amphorae have been found in Greece and Lebanon) (19, 44).

At the mouth of the Rhone River, seagoing ships could offload cargo onto riverboats headed north into the heart of Europe. Plotting amphora finds in cities, towns, and military camps along major rivers, such as the Rhone and Rhine Rivers, has also identified interior trade routes by which fish byproducts from Mediterranean salteries made their way to soldiers, government functionaries, and others (43). Dedicatory inscriptions, dated to the late second- or early third-century AD, show that fish sauce merchants even carried their products across the Channel to Britain, where amphora finds document fish sauce in London, York, and along Hadrian's Wall (45). Found at the mouth of the Rhone River was a small, 2-handled terracotta vessel that bore a painted label that identified the contents as garum produced by Aulus Umbricius Scaurus, the noted fish sauce tycoon of Pompeii (46). Archaeological evidence at Pompeii permits a close look at the pervasiveness of fish sauce in the daily life and economy of a small Roman coastal town of the first-century AD.

Pompeii, located in the Bay of Naples, was destroyed by Mt Vesuvius in AD 79. Pliny the Elder's praise of Pompeian garum by name implies that the town had a flourishing fish-processing industry (33). Unfortunately, the salting installations, wherever they were, remain buried under many feet of volcanic ash and pyroclastic material. Excavations, however, have uncovered a house (Reg. I.12.8) in the city itself, where garum was prepared (47). Formerly a private residence, it was renovated and converted to a garum shop at some time after AD 62. The shop contained no salting vats similar to those found in factories in Spain and elsewhere. Workers apparently processed the sauce in the 6 dolia located in the former garden (**Figure 3**). When first excavated in 1960, all of these storage jars contained the dried remains of *allec*. This establishment was probably not a retail shop but a central point where garum, which was processed elsewhere, was further refined, perhaps with herbs grown in the garden. The owner apparently operated as a middleman between the producer and the retailer or exporter. His identity and whether he also had a retail shop in the city are unknown. Evidence for the popularity and easy availability of fish sauce in Pompeii



FIGURE 2. Salting vats (*cetariae*) at Almuñecar, Spain.

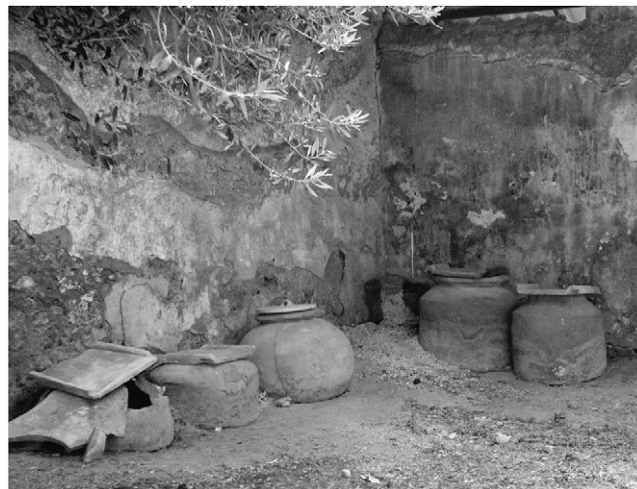


FIGURE 3. Dolia containing fish sauce (*allec*) in the garden of the garum shop in Pompeii.

comes from the widespread distribution of the distinctive local fish sauce container, the urceus (**Figure 4**).

Of ≈ 200 inscribed fish sauce vessels found in Pompeii and Herculaneum, >150 ($\approx 78\%$) are small, one-handed vessels called urcei; 90% of these are Pompeian Type VI vessels (48). It seems that this was the vessel that most often held fish sauce, and customers could probably identify the product at a glance by the shape of the container. These vessels have been discovered by archaeologists throughout the city, in areas commonly used for food preparation, sale, and consumption, including food shops, and in kitchens and gardens of villas and houses both modest and splendid. Such findings indicate that fish sauce was readily available and used by people of all walks of life. The large number and varied find spots of these vessels strongly imply the existence of a ready market for these products. Indeed, the variety of names appearing in painted labels on these vessels indicates that a sizable number of local entrepreneurs competed for market share. Of the names found on such labels, those linked with the family of Aulus Umbricius Scaurus, including his slaves and freedmen, appear on 28% of all inscribed fish sauce containers found in Pompeii and nearby Herculaneum (48).

Epigraphic and archaeological evidence provides key information about this family and its fish sauce business. For example, the sepulchral inscription (CIL 10.1024) on the family tomb provides information about Scaurus' family and its standing in the community:

“To Aulus Umbricius Scaurus, the son of Aulus, of the tribe of Menenia; Duovir with Judicial Authority; to this man the Decuriones have decreed the place for his tomb and

2 thousand sesterces toward the cost of his funeral and an equestrian statue to be placed in the forum. Scaurus the father to his son.”

Scaurus belonged to a wealthy, probably land-owning, family; his son reached the highest political office in the city (48).

Scaurus lived in an elegant, multistoried house with 3 atria, or living rooms (Reg VII Ins Occ 12–15). The secondary atrium of Entrance 15 possessed a black-and-white figural mosaic floor (49). At each corner of a central water basin (*impluvium*), white *tesserae* formed the design of a one-handed Pompeian Form VI vessel. Each mosaic vessel, ≈ 0.6 m in height, had a mosaic design mimicking the painted labels that appear on real Type VI urcei (Figure 4). This uniquely personalized mosaic design, to my knowledge, has no parallels anywhere in the Roman world. Beginning in the lower right, the mosaic urcei with labels appear as follows:

- 1) G(ari) F(los) SCO[m]/ SCAURI/ EX OFFI[ci]/NA SCAU/RI (The flower of garum, made of the mackerel, a product of Scaurus, from the shop of Scaurus)
- 2) LIQU[mini]s/ FLOS (The flower of Liquamen)
- 3) G[ari] F[los] SCOM[bri]/ SCAURI (The flower of garum, made of the mackerel, a product of Scaurus)
- 4) LIQUAMEN/ OPTIMUM/ EX OFFICI[n]/A SCAURI (The best liquamen, from the shop of Scaurus)

Just as painted labels on Scaurus' real urcei identify and advertise the products that created his wealth, so Scaurus advertises himself through the mosaic designs in his home.

Pompeians who visited Scaurus' house would have already been familiar with fish sauce, the container that typically held it, the information contained in the label, and Scaurus' near domination of the market. They would have known that Scaurus owned a primary shop and either owned or controlled through family members, freedmen, or slaves perhaps ≥ 6 additional shops in the city. Fifteen other people, whose names appear recorded on fish sauce labels, may have operated garum shops independently of Scaurus (48). It seems clear that the fish sauce business in Pompeii was a thriving one, supplying the culinary needs of a population of between 12,000 and 15,000 individuals.

To study Roman fishery byproducts today, we can call on a wide variety of literary and archaeological evidence as well as modern comparative data. Ancient historians and archaeologists, assisted by scientists, such as biochemists and microbiologists, have amassed a wealth of information about these commercially important food products. Remarkably similar to its modern counterparts, ancient fish sauce probably exhibited a clear, reddish brown or amber color and presented a decidedly robust, though not offensive, odor. It imparted to Roman dishes a moderately strong, salty, but slightly fishy taste. In synergistic combination with other foods, Roman fish sauce created the flavor that we now associate with oriental cuisine. Two thousand years ago, umami was the characteristic taste of Western cuisine. It is nice to see that it is becoming so once more. (Other articles in this supplement to the Journal include references 50–78.)

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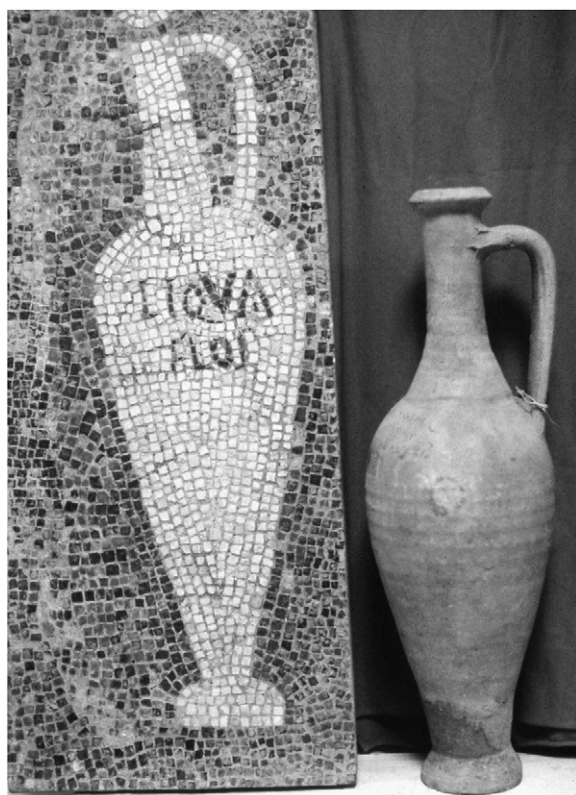


FIGURE 4. Urceus of Pompeian Form VI.

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