Chapter 26
Mead: The Oldest Alcoholic Beverage

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26.1 The Importance of Honey in the Past

The word honey conjures up images of warmth; we might address someone we love as 'honey', and a honeymoon is a time of hope and happiness. Although there are no exact figures for per capita consumption of honey through history, a general assumption is that it was a scarce commodity (Allsop and Miller 1996). However, according to a reappraisal of the evidence through history, honey was sold in large amounts, and mead, an alcoholic drink from the fermentation of honey, became a common alcoholic beverage (Allsop and Miller 1996). It is suggested that ordinary people consumed as much honey as the current consumption of refined sugar. As well as drawings in the Cave of the Spider (Spain), there are many other drawings that indicate the high value that honey had in the past. However, despite all of these indications of how well honey was appreciated, there appear to be no records of the amounts that were actually consumed. Instead, studies of present-day hunter–gatherers can provide approximations to the situation in the past, where honey was obviously plentiful. In Tanzania, for example, of all food eaten, meat and honey constituted 20 % by weight; in energy terms, this amounts to significantly more than 20 % (Woodburn 1963). In Congo, pygmies can cover up to 80 % of their energy needs with honey during the honey season (Crane 1983), while in Sri Lanka, honey was also used to preserve meat for times of scarcity (Crane 1983).

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26.2 An Introduction to the History of Mead

While no one can pinpoint the exact time period when or location where mead was first discovered, there is evidence of it in nearly every ancient culture. Mead is an alcoholic drink produced by the fermentation of honey. After gathering the honey, the natural yeast and high moisture content cause the honey to ferment. Traditionally, mead is produced by diluting the honey with water and by addition of yeast. As in the past, mead can be produced in many variations, including as a plain honey wine (traditional, with honey only), flavoured with fruit (melomel), spices (metheglin), or vegetables, or with any combination of ingredients; here, the choice is only limited by the imagination of the brewer and the resources at hand. The alcoholic content of mead can range from about 8 to 18 % (Lichine 1987). It can be still, carbonated or sparkling, and it can be dry, semisweet or sweet (Rose 1977). In terms of the oldest alcoholic beverage on the earth beer, wine and mead remain in competition for the crown as the first fermented beverage.

No other sugar-containing foodstuff available in antiquity can surpass honey. Collecting honey was one of the first organised agriculture practices. Ancient cave paintings depict the earliest people stealing this sweet treasure from the bees. In the above-mentioned Cave of the Spider (Cueva de la Arana), a prehistoric cave discovered in Valencia, Spain, which is situated on the river Cazunta, drawings have been found that are estimated to be about 8000–15,000 years old. Here, two human figures are seen on a rope ladder, in the process of robbing the bees of their honey in a cave entrance (McGee 1984). Ancient people simply expelled the bees from their hives using smoke and then collected the honey. These bees, which would have been wild rather than domesticated, were then destined to die due to lack of food during the winter. Thus, archaeology acknowledges the existence of honey hunters from well before any evidence of beer or wine.

It is evident from written and pictorial records that beer making dates back to Mesopotamia, from about 4000 BC. Brewing and wine production have also been found in pictorial archaeological records dating back to 3000 BC, where both crafts had developed to the stage where the process had been standardised (Schramm 2003). Brewing and winemaking then evolved further, and they became sources of employment and trade for a considerable period. There is widely accepted evidence that cereal grains were cultivated from 9500 to 8000 BC, with evidence that wine was made at least in the Neolithic period; in 1996, a jar dating back to 5400–5000 BC was found at a Stone Age site in Iran that contained traces of wine residues (Riches 2009). The competition for the crown as the first fermented beverage continues to be fierce, however, with the end of the ice age bringing suitable conditions for viticulture and horticulture. Cereals and grapes were first used as food and then later on as fermentable substrates to produce alcoholic beverages.

Evidence of viticulture dates back to 8000–5000 BC, and this has been extrapolated, maybe debatably, to indicate winemaking. The first regions where grapes were grown included the previous Soviet republic of Georgia, Turkey, Syria and Jordan. During archaeological excavations in Armenia, a few dozen 6000-year-old

karstic caves were discovered. In one cave, known as Areni-1 cave, evidence of the completion of the full cycle of winemaking was found in the Copper Age layer.

While there is substantial evidence regarding horticulture and viticulture, it is only colourful folklore that can enlighten about the primordial fermentation process. Although they lay claim to the crown for the first alcoholic beverage, mead makers have not been as well organised as brewers, who have even sponsored archaeological beer projects. Nevertheless, mead makers base their claim on the argument that honey was the first fermentable substrate, as is also well documented in the earliest pictorial evidence. Similarly, from archaeobotany, which is the discipline that deals with the archaeobotanical evidence of food and involves the search for plant microfossils that were present in food or beverages. Under certain conditions, food remains can be well preserved, preventing their decomposition. In the case of honey, pollen preserved by copper salts or drying might also indicate mead (Rosch 2005).

26.2.1 Mead in China

It appears that the earliest archaeological evidence for the production of mead itself dates to around 7000 BC. In the Neolithic village of Jiahu, in the Henan province of Northern China, remnants of an alcoholic beverage were found in 9000-year-old pottery jars (McGovern et al. 2004). These Neolithic people were brewing a type of mead, with an alcohol content of 10 % and which consisted of wild grapes, honey and rice. This thus produced the so-called wine–mead–sake, which indeed lays claim to the oldest record of any alcohol-containing beverage.

Compared to the grape and grain, the production of which is limited by pedoclimatic conditions; honey can be produced over a much wider geographical area. Schramm (2003) indicated that anthropologists are in good agreement that the beginnings of mead production should date back to around 8000 BC. Indeed, it appears that several cultures around the globe were producing mead at the same time, without having knowledge of each other.

26.2.2 Etymological Research of Mead

Etymological research has shown that mead is such an ancient beverage and that the linguistic root for mead, *medhu*, is the same in all of the Indo-European languages, where it took on a relatively wide range of meanings, including honey, sweet, intoxicating, drunk and drunkenness. This thus provides further evidence for the suggestion that fermented honey is the oldest form of alcohol known to man (Aasvad 1988) (Table 26.1).

Table 26.1 Examples from etymology dictionaries of the roots of mead in other languages

Language	"Mead" root	Meaning
Old English	*Medu*	Mead
Proto-Germanic	*Meduz*	Mead
Cf. O.N.	*Mjöðr*	Mead
Danish	*Mjød*	Mead
O. Fris. Middle Dutch	*Mede*	Mead
German	*Met*	Mead
From PIE base	*Medhu*	Honey, sweet drink
Sanskrit	*Madhu*	Sweet, sweet drink, wine, honey
Greek	*Methy*	Wine
O.C.S.	*Medu*	Mead
Lithuanian	*Medus*	Honey
Old Irish	*Mid*	Mead
Welsh	*Medd*	Mead
Breton	*Mez*	Mead
Slovenian	*Medica*	Mead
Polish	*Miód*	Mead
Baltic	*Midus*	Mead
Old Norse	*Mjöð*	Mead

26.2.3 Mead in Egypt

In Egypt, early evidence of beekeeping dates back to 2500 BC; at that time, honey was used as a household sweetener (Schramm 2003). Egyptians domesticated bees and they probably developed the first beehives, which were made of unbaked clay or of woven baskets covered with mud. The hives could be opened from the back, and the bees were forced out using smoke. The honey was harvested twice a year, with the combs placed on cow skin and crushed. The honey was then separated through small holes and filtered through blades of straw, to get rid of the impurities. All of these procedures have been depicted in different ancient Egyptian tombs. Honey was also mentioned as being fermentable in the Hymn to Ninkasi (Schramm 2003), and it became an important agricultural commodity in trading.

26.2.4 Mead in Ancient Greece

Honey was the first and only sweetener that the ancient Greeks had in their diet. It is worth mentioning that the Greeks develop an advanced hive system, with removable bars that enabled the harvest of the honey without disturbing the brood. Ancient Greek authors praised the medicinal and nutritional values of honey, and the Iliad refers to honey as the food of kings, while mead was considered a high beverage among ancient Greeks. The Greeks were very fond of using spices and herbs in their cuisine, including in their wine and mead.

26.2.5 Mead in the Roman Empire

In the ancient Roman Empire, honey was very popular, as it was in other Mediterranean states. It is speculated that the Phoenicians and early Greek settlers brought their apiculture knowledge to the Roman Empire, where it then flourished. Bees and honey were of great esteem for Virgil, who felt that honey was a gift from heaven. The famous Roman writer Pliny devoted many chapters to honey collected from the sweet juices of flowers and to the beneficial effects of honey on health. Beekeeping was also particularly advanced, as the Romans had at least nine types of beehives that were made of clay, cork, wicker and wood. Mead was omnipresent during the Roman Empire, and the Romans also produced *mulsum*, a traditional grape wine that was sweetened with honey. Pliny the Elder described how to make *hydromel*, a mead made of three parts water and one part honey, where this honey–water solution was left to ferment outside for 40 days. The Romans often used herbs infused in mead, where their extraction was helped by means of the alcohol. Schramm (2003) described in his book how the word *metheglin*, meaning 'mead with herbs', consisted of the Latin *medicus* (medicinal) and the Irish *ilyn* (liquor).

26.2.6 The Middle Ages

The oldest record of mead in Europe dates back to 2500 BC. That evidence was found in 1984, in an archaeological dig on Rum Island West of Scotland. Scientists proved that ingredients in a pot of dried mead appeared to be heather honey, oats, barley, royal fern and meadowsweet.

Lithuanian ancestors, Balts, were using mead thousands of years ago (since 1600 BC). Mead was drank out of drinking horns coated with metal in the period from the fourth to sixth century AD. The tradition of mead in Europe was pursued most in areas less suitable for wine grapes (England, Scandinavia, Eastern Europe), which explains the enthusiasm of the Vikings for mead. The monasteries were skilled in keeping bees and brewing, although mead making was a by-product of beekeeping.

The wooden bowls used by English mead drinkers during the Middle Ages were known as *mazers*.

The Book of Taliesin is one of the most famous of Middle Welsh manuscripts, where Kanu y med or song of mead was written probably around 550 AD. Mead is mentioned in many stanzas in Y Gododdin, a medieval Welsh poem dating to around 700 AD. In Scandinavian mythology, Valhalla is a majestic, enormous hall located in Asgard, ruled over by the god Odin. In Norse mythology, mead was the favourite drink of the Norse gods and heroes, e.g. in Valhalla as mentioned in Chap. 39. Snorri Sturlason (1179–1241) lived in Iceland, and he wrote a saga of all of the Viking kings, and most of it is believed to be at least near to being correct historically (Fig. 26.1). This saga has been printed in numerous editions over the last 200 years. The use of mead (and beer) is an element of many of these stories.

Fig. 26.1 Drawing by Erik Werenskiold showing King Fjolne falling into the mead barrel (Sturlason 1942). Some authors say that Fjolne became a King in Uppsala, or maybe he was just a mythical story

During reformation there was no need for luxury in Catholic churches and for their candles. Beekeepers lost an important part of their income due to the drop in the demand for wax. As a consequence, the prices of honey increased and mead was no longer affordable. In countries that remained Catholic, like Poland or Russia, mead remained a favoured drink among the nobles. As mentioned by Gayre and Papazian (1983) in their book, mead was for the great and grand occasions, while ale was for the masses and for all times. In Russia, mead remained popular as medovukha and sbiten long after its popularity declined in the West. Sbiten is often mentioned in the works by nineteenth-century Russian writers, including Gogol, Dostoevsky and Tolstoy.

After the introduction of wine from the Mediterranean countries, mead was also looked upon as more of a countryman's drink and lost its popularity among the nobility. However, it did not lose its popularity among the common folk because, like beer, it could be made from materials at hand, and unlike wine, it didn't require special temperatures for storage or ageing. However, beer was much less expensive to produce and gradually replaced mead as the daily drink of all classes.

26.2.7 Symbolism of the Honeymoon

According to legend, the word *honeymoon* derives from an ancient tradition of sending a newly married couple off to seclusion for a month with much mead. Drinking mead would have ensured their best chance to start a family quickly; indeed, mead has been, and still is, considered the drink of love. The term honeymoon is packed

with symbolism, and mead, or honey wine, is sweet and symbolises the particular sweetness of the first month of marriage. It is a time free of the stresses and tensions that everyday life puts on a relationship as time goes by. The moon symbolises the phases or cycles of the couple's relationship as it extends from new moon to full moon. Like the moon, the couple's relationship would have its brighter moments and its darker ones. Being tied in with the moon cycle, the 1-month period of time was also considered to be associated with the woman's menstrual cycle and thus, her fertility. However, the real claim to fame for mead is in its origins during the wedding celebrations; it was believed that if the couple drank mead daily during the honeymoon, they would be assured of fertility and the birth of sons. Some customs sent the bride to bed and then filled the bridegroom with mead until he could no longer stand. He was then delivered to the bride's bedside to sire a son that very night. If the bride did indeed bear a son 9 months later, the maker of the mead would be complimented on its quality. This concept arose as it was widely believed that honey would promote the birth of a male child, and it was considered very lucky when the firstborn to a newly married couple was a boy. Therefore, on the day of their wedding, the father of the groom would give the couple enough honey to last a full month, or *moon*, thus hopefully assuring that the child conceived during the first days of the marriage would be a boy. Oddly enough, modern science appears to support this theory. Apparently, a diet rich in honey alters the female pH levels enough to provide a favourable environment for the conception of a male.

26.3 Mead Varieties

Many versions of mead are known today, and many of them are still being produced locally. Thus, many recipes include as a source of sugar, besides honey, also herbs, fruit or grain.

26.3.1 Meads from Caramelised Honey

Bochet mead or burnt mead is prepared in a way that honey is heavily caramelised or burnt. Afterwards, the procedure is similar to ordinary mead. Mead has a charred character with impressions of toffee, chocolate and marshmallow flavours.

26.3.2 Melomel Types of Mead

When honey is mixed with fruit juice, the resulting fermentation is a type of mead known as melomel. When the fruit juice used in making melomel is apple juice, the resulting fermentation is known as *cyser*. Mead, in Russia known as *medovukha* or *stavlenniy myod*, is made from honey, but a version with the addition of berries is

also known. In Russia, mead was drunk to celebrate pagan god Perun. Lithuanian mead called midus is made similarly by fermenting honey and berry juice. Morat is considered a traditional drink of the Saxons, made with honey fermented with mulberries. Pyment is considered a type of fruit mead fermented with red or white varieties of grapes. It shares sensory properties of both traditional mead and wine. Grape varieties like Pinot noir and Barbera are mentioned. Pyment may be spiced by storing it in casks to enrich it with vanilla overtone.

Omphacomel is a style of mead mixed with an acidic liquid pressed from unripe grapes.

A Finnish type of mead called sima is another fruit type of mead flavoured by adding both the juice and zested rind of a lemon. When mead is brewed with black currant, it is called black mead.

Mead called acerglyn is produced from honey and maple syrup in the USA and Canada.

26.3.3 Mead with Spices

Meads seasoned with different spices, also called metheglin, have been produced throughout history.

In Mexico, Maya Indians are still producing mead called balche with the bark of a leguminous tree (*Lonchocarpus violaceus*), which is soaked in honey and water and fermented. Balche is an intoxicating beverage that was drunk during rituals and was considered to have magic power. Xtabentún is a similar beverage made of honey produced from the nectar of *Turbina corymbosa*. Pittarilla is a similar mead produced by Mayans using honey and balche tree bark.

Braggot is a mead made with malt and honey. It may be called honey bear because of the addition of hop. It is considered to be of Welsh origin.

Capsicumel or capsimel is a mead made with chillies. It is named for the spicy chemical capsaicin and the genus of chilli plants, *Capsicum*. The mead must be sweet to balance the heat, but not so sweet that the flavours of the base honey and chillies are masked.

Dandaghare is mead made in Nepal from honey and local herbs and spices. Croatian mead is called medovina or gverc and is made from honey and different spices.

Iqhilika is a traditional mead from South Africa. According to the traditional method, the ingredients are honey, water, roots of an indigenous succulent herb known as *imoela* and pollen.

Tej is a famous mead made in Ethiopia. It is made from local honey and flavoured with smoke and leaves and twigs of gesho (Rhamnus prinoides) that gives a hop-like taste.

Rhodomel is produced from honey, water and rose petals or distillate from rose petals.

Oxymel is made of honey and water, with vinegar added at the end of fermentation. It was used mainly for medicinal purposes.

26.3.4 Fortified Meads

Some meads are produced using more honey than traditionally used, and so the final product contains elevated levels of non-fermented sugars. This category includes sack mead and Polish meads called dwojniak and poltorak.

26.3.5 Plain Meads

Plain meads are produced from honey and water only. This category includes medicinal products produced in Slovenia and Croatia and show mead. In Slovenia, the oldest known recipe of mead originates in the seventeenth century. Czwórniak is a plain mead produced in Poland from nectar honey. Chouchen is also a plain mead produced in Brittany from honey and water, sometimes using seawater instead of freshwater.

26.3.6 Mead Distillates

Any type of mead may be distilled to produce brandy with higher alcohol content. Lithuanian mead midus enriched with the extracts from different herbs, flowers, or buds is distilled to produce a fortified beverage containing up to 75 % of alcohol. Medenovec is a Slovenian mead brandy that contains 32–35 % of alcohol. It can be made with any type of honey, but aromatic honeys are preferred.

26.4 Processes

26.4.1 Early Fermentation

Throughout history, the production of alcoholic beverages was a glorious habit of humans everywhere in the world. Indeed, many and various foodstuffs that contained sugar were used to produce alcohol. The most common foodstuffs were fruit, grain and vegetables, but the important advantage of honey was its good storability. Furthermore, much less care was needed to carry out the fermentation, compared to other foodstuffs. For this fermentation, the appropriate vessel seemed to have been of great importance. Although often representations in pottery are the most important historical proof, the first watertight vessels used by humans would probably have been animal skins and some animal organs (Schramm 2003). Crane (1983) supported this hypothesis further by indicating that African honey hunters used animal skins and gourd containers. In his book, Schramm (2003) hypothesised that the

first spontaneous fermentation could have taken place in these skin containers. The hunters would fill their containers with water, and possibly later during their hunting they would have stored the honey together with this water. At the beginning, this honey–water beverage was probably esteemed by the hunters, due to the pleasant taste, and later on, once fermentation had taken place, this would have provoked great amazement.

26.4.2 Microorganisms in Mead Processing

Indigenous microorganisms naturally present either in the honey or on the equipment used usually promote the fermentation process (Ashenafi 2006). Yeast cannot grow in solutions where sugar concentrations exceed 22 %, while on the other hand, 14 % alcohol arrests fermentation (Stong 1972). Besides high osmotic pressure and increased alcohol content, some inhibitory compounds in honey can also make the fermentation process difficult to start (Pons and Schutze 1994). Due to these reasons, the fermentation of honey usually proceeds slowly and might get blocked before completion.

As well as these inhibitory agents, various nutrients are also present in honey. It is generally believed that dark-coloured honeys contain more nutrients compared to light-coloured honeys. To give an example, wort made from buckwheat honey is known to ferment much faster than one made from clover honey. Caridi et al. (1999) investigated honey fermentation with different yeast strains for each honey variety, because each honey source can contain specific factors that might hinder the fermentation process. They thus isolated four yeast strains that have suitable, but different, characteristics, such as high fermentation vigour, ability to produce mead with a low pH, good resistance to higher ethanol content and ability to produce low volatile acidity (Caridi et al. 1999). Among these characteristics that are related to the fermentation vigour, resistance to ethanol and the ability to produce a low content of volatile acidity are particularly important for mead production.

As indicated above, mead fermentation is a rather slow process, and it often takes from one to several months to accomplish. To increase the fermentation rate, Navratil et al. (2001) experimented with immobilised cells of *Saccharomyces cerevisiae*, using ionotropic gelation of pectate, which proved to be more stable when compared to alginate. This process was continuous and stable and took only a week to complete the fermentation (Navratil et al. 2001). Other authors have recommended the use of champagne yeasts (White 1994), while Vidrih and Hribar (2007) used *Saccharomyces bayanus* to carry out the fermentation.

26.4.3 The Importance of the Fermentative Microflora

It can happen that mead is not drinkable after fermentation, which would be due to the uncontrolled development of wild yeasts and bacteria (Mendes-Ferreira et al. 2010). Honey is considered an ideal medium for the growth of many undesirable

microorganisms, which can multiply if they are not suppressed by the yeast (Dumont 1992). Thus, to prevent uncontrolled fermentation and to promote a faster start, selected strains of yeast or commercial yeast preparations have been introduced (Pereira et al. 2009). Using selected yeast significantly improves the overall quality of mead, but problems like a lack of uniformity across batches and an arrest of fermentation before completion are often found. Pereira et al. (2009) attributed these problems to the yeast strain. During mead processing, yeast encounters especially difficult conditions, due to high osmotic pressure, higher ethanol content, lack of nutrients and inhibitors present in some types of honey.

In old recipes, the addition of herbs, fruit and other additives was suggested, to enrich the flavour and taste of the mead. On the other hand, as speculated by Morse and Steinkraus (1975), the use of various additives could well have been an attempt to mask an incorrect aroma or flavour of a mead. More recent recipes can also recommend additives, such as grape juice, to produce red-coloured mead (White 1994).

26.4.4 Wort Pasteurisation Prior to Fermentation

Heat treatment of honey solutions is a traditional method that is still used by mead manufacturers today. As mentioned by Stong (1972), the boiling of diluted honey has the advantage of yielding a mead that clears more rapidly and has a better overall stability during its shelf life. The boiling of the diluted honey for 30 min is sufficient to prevent cloudiness, which might otherwise persist for several months. Changes like an altered colour and aroma profile were reported by Kime et al. (1991a). As a result of this heat treatment before fermentation, Wintersteen et al. (2005) found that the antioxidative potential of the mead was altered.

Another important advantage of this pasteurisation is the elimination of all of the microflora, so that the fermentation can start with the addition of the selected yeast. The goal of this procedure is thus also to produce a more uniform mead across different batches.

26.4.5 Application of Ultrafiltration

As mentioned above, heat treatment successfully prevents spontaneous microflora from carrying out the fermentation, and it promotes rapid clarification of the mead after fermentation. However, this also has its negative aspects, as heat treatment can lead to oxidation, browning and undesirable flavours. As already observed by Kime et al. (1991a), a further technique is to use pasteurisation at a high temperature, but for a short time (30 s), which has been shown to substantially improved the overall quality of the mead compared to traditional pasteurisation. The same authors studied the application of ultrafiltration of the wort before fermentation (Kime et al. 1991a, b). Ultrafiltration is widely used in the food industry to remove selected

particles according to their molecular size. The solution to be filtered flows under hydrostatic pressure against a semipermeable membrane, which allows only the water and the low-molecular-weight solutes to pass through. The membrane surface is selective for a particular molecular weight, and so the solids and solutes that have higher molecular weights and that are responsible for haziness are retained and thus removed from the solution. The main advantage of applying ultrafiltration for mead production is the superior mead quality achieved, with a superior flavour, taste, colour and stability, and a mead that clarifies immediately after the fermentation. Such ultrafiltered mead is said to have a smoother and 'cleaner' flavour, compared to conventional processing (Kime et al. 1991a, b).

26.5 Consumer Aspects

26.5.1 Nutritionally Improved Mead

Nowadays, producers keep trying to improve the nutritional value of many traditional food products. A main route for these modifications is the addition of various ingredients, like vitamins or minerals. On the other hand, different plant extracts that are especially rich in polyphenols can be used to improve antioxidative potential, colour and/or flavour of food products. With regard to novel types of mead, producers have tried to enrich mead for attributes like a better antioxidative potential or improved sensory characteristics.

Koguchi et al. (2009) produced novel types of mead from honey that originated from Chinese milk vetch and from buckwheat, and they enriched these by adding grains of black rice (*Oryza sativa var. Indica cv. Shiun*). The milled black rice was added just before the start of the fermentation. The mead produced in this way was more red in colour and was characterised by a higher content of total polyphenols and a higher antioxidative potential, compared to the control mead.

26.5.2 Aroma and Flavour of Mead

Although mead is considered the oldest alcoholic beverage, scientific studies regarding all aspects of mead are very rare.

As is the case with other alcoholic beverages, the overall aroma of mead arises from the aroma compounds that originate from the floral source of the honey. These represent the so-called fermentative aroma compounds that are formed by microorganisms during fermentation and from the maturation aroma compounds formed during maturation. Each type of honey is characterised by its own typical aroma compounds, which originate from the primary floral source.

Having in mind the aroma compounds in mead, Vidrih and Hribar (2007) studied the synthesis of the higher alcohols, while Wintersteen et al. (2005) investigated the

influence on the aroma volatiles of the heat treatment of the wort before fermentation. Higher alcohols are predominant aroma volatiles, and their synthesis is dependent on the honey source, the nitrogen content and the fermentation temperature (Vidrih and Hribar 2007; Mendes-Ferreira et al. 2010). As these higher alcohols can impart an unpleasant sensation to the mead (a grass-like taste and flavour), their synthesis should be limited. The widely accepted upper limit for the total content of higher alcohols is 300 mg/L, with higher content being detrimental to quality (Rapp and Mandery 1987). On the other hand, the higher alcohols are suitable substrates for the synthesis of their corresponding esters (butyl, isoamyl), which are formed during mead maturation. The practice of controlling the fermentation temperature and the use of supplementation of nitrogen at the start of the fermentation are widely accepted practices in wine processing, and they are also well accepted by mead producers.

As well as yeast, lactic acid bacteria also find a suitable medium during mead processing (Bahiru et al. 2006). Both yeast and lactic acid bacteria are known to synthesise numerous aroma volatiles that contribute to the flavour and aroma of mead.

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