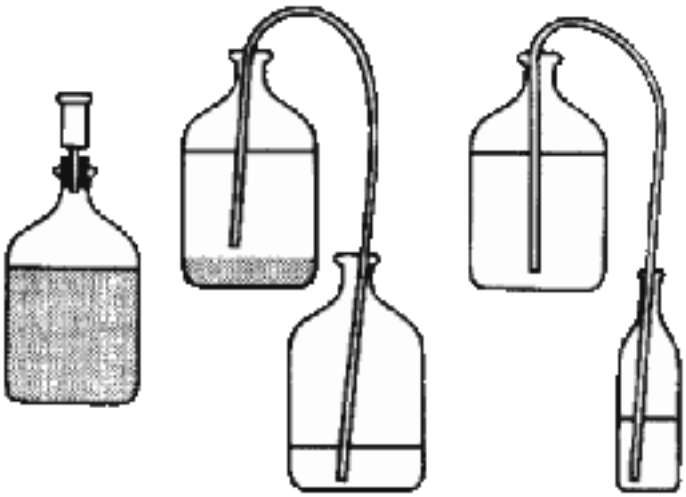
# Mead making







*Steps of mead making: fermentation, racking, bottling (after [V1])*

- Small batches Why the size of a batch can matter.
- Is mead making easy or hard?
- Chemicals or no chemicals -- Organic meads vs. use of chemicals
- The main ingredients for making mead: honey, yeast, water

- The equipment you need for making mead
- Chemicals which can be used in mead making: acids, sulfite, fining agents, yeast nutrients
- Procedure (recipe) to make mead
- Recipes using fruits, making sparkling mead
- Troubleshooting problems that can arise when one makes mead: stuck fermentation, funny aspect or smell

June 9th 2002

# Small batches



Small batches



It can be interesting, to get started, to make mead in quantities smaller than the one used in the recipe (what do I do with these 20 liters of vinegar or of bacteria culture?)

Small amounts can be used for experiments: instead of making 5 gallons of 1 mead, it can be better to make 5 meads of 1 gallon each. This allows to try new yeasts and honeys. It is not required to make 20 liters of mead with some exotic honey whose taste and cost are unusual.

This also allows to get used to fermentation techniques without logistics troubles like handling more than 10 liters of boiling water or a carboy weighing more than 20 kg (40 lbs).

Small amounts also have drawbacks. The surface area/volume ratio increase and so does the risk of oxidation. Some of the losses are independent of the volume (sampling for tasting or chemical analysis as well as losses due to rackings are proportionally higher with low volumes). Cost and labor will also be greater: 1 dose of yeast, 1 stopper, 1 airlock are necessary for 1 gallon as well as for 5 gallons. Measurements also become a problem: the smaller the amount the larger the relative mistake. Being off by 1 g out of 4 g does not have the same consequences as being off by 1 g out of 20 g.

May 28th 2002

# Is making mead easy or hard?



Small batches

Easy or hard?



Why it is easier to make mead than wine:

- no need to worry about ripeness, the acid or sugar content of the fruits,
- lower risk of bacteria infection in honey and no risk of having sulfur at all,
- no tight schedule because of harvest, the production can be scheduled more conveniently,
- nobody knows mead: if you have friends taste wine you made, comments could be like: "it tastes like Bordeaux, just not as good". If people do not like the mead you made, it is possible to pretend that they just do not like mead in general.

Why it is harder to make mead than wine:

- absolute lack of milestones, references, reliable recipes.

Why it is easier to make mead than beer:

- hops can be troublesome and they are sensitive to light (hence the brown bottles),
- precise temperature cycles,
- as for wine, there can be a good prejudice: most of the time the mead maker is the better specialist of mead among the tasters.

Why it is harder to make mead than beer:

- same: lack of milestones, references, recipes. Beer brewers can ever describe the kind of water that best fits every kind of beer whereas there are not even to mead makers who agree about what honey to use.

May 28th 2002

# Chemicals or no chemicals
# Organic meads *vs.* use of chemicals



Some people can explain at length what nutrients to use, how to use sulfites or acids. Others will tell you how to make mead using only honey, water and yeast, without adding anything else.

### Who is right?

Does it really matter? Is this the important dichotomy? I would argue that however you make it, at the end of the day, what matters is how your mead turns out. It is pointless to be proud of one's organic mead if it is not good. It is also pointless to be proud of fermenting a mead in two weeks if it takes months to age. It is pointless to boast about not using sulfite if the mead is not stable during aging. What matters is how good the mead is after a given time. Which mead is best at the end of fermentation? Which one ages best?

I cannot answer this question; it is sure that both methods can lead to good meads. My point is that this may not be the right question to ask and very often it is just a dogma which has not been proven. Instead of being proud of fermenting mead in two weeks or of not using nutrients or sulfite, it may be better to actually test the effect of these points of view. Use no nutrients, some nutrients and a lot of nutrients and compare the speed of fermentation as well as the taste of mead at the end of fermentation and after some aging. Bottle mead with and without sulfite and compare the stability of the two batches. If it turns out

that indeed a two week fermentation or the absence of nutrients or sulfite gives as good (or better) a result than other methods, stick with it. Otherwise, revise your religion. No religion can be as important as making a good mead.

April 16th 2003

# Ingredients





There are three main ingredients you need to make mead: honey, yeast and water. You may use more than these three but only these three have to be used.

## Honey

All authors dealing with wines agree about it: grape is the single most important thing in wine making. Trying to imitate a great wine with poor grapes will result in a poor wine. So attention should be paid to the honey you use.

Go to the honey section.

## Yeast

The strain of yeast will determine the length and ease of the fermentation and part of the flavor profile

Go to the yeast page.

## Water

Go to the water page.

January 22nd 2003

# Equipment



- 2 5 gallon carboys. Use vessels made out of glass (fragile but funny: it is possible to see what is going on inside) or stainless steel. Plastic can be hard to clean but some of them seem to be usable for short periods and wood is more suitable for ageing than for fermentation,
- 3-4 gallon pot (enameled or stainless steel as aluminum can react in an acidic environment),
- 2 qt vessel for the starter,
- drilled rubber stopper + air-lock (figure 3),
- (thermometer to monitor temperature for sanitation of honey),
- (hydrometer to measure the specific gravity (density) of the must and extrapolate the potential alcohol content),
- big spoon to stir honey while it is heated (avoid wood which is porous and therefore hard to sanitize),
- (pH-meter),
- funnel (big enough to avoid pouring out of the carboy (it is not easy to aim when handling gallons of water)),
- transparent hose made of food grade plastic,
- 25 75 cl bottles + corks,
- measuring spoons for quantities as small as 1/4 or 1/8 tsp (tea spoon) which are common for some chemicals,
- scale or equivalent to measure quantities of honey.

## Sanitation

There are two solutions to avoid a bacterial invasion: having no bacteria in the first place or killing them when they show up. Or both.

So it is necessary to take great care of the cleanliness of the material to be used. Do not touch sensitive parts of the material (bottom of rubber stopper, inside of carboy and bottle necks, etc.) with fingers. Keep contact with air to a minimum to prevent bacteria from entering.

Conditions hostile to bacteria must also be maintained:

- small quantity of nutrients (sweeter meads having more sugar are riskier),
- low pH (acidic environment),
- high alcohol content,
- presence of antiseptic (sulfite).

These conditions are unfavorable for yeasts as well but yeasts have been selected if not trained to withstand them. Wine yeasts can tolerate an alcohol content around 15 % (30 proof) but -- most -- bacteria cannot live when there is more than 2-4 % alcohol. Beer (8-10 proof) keeps for a few months, wine (125 proof) for years and brandies (80+ proof) forever. A vigorous fermentation produces alcohol quickly and within a few days the must becomes inhospitable for bacteria.

May 28th 2002

# Chemicals



- Fining agents When the mead won't clarify, fining agents may be the solution
- Sulfite is an antioxygen and an antiseptic use dto preserve mead
- Other chemicals: nutrients, acids, vitamine C, sorbic acid

January 22nd 2003

# Fining agents



Normally, most meads will clear by themselves, one just has to be patient. Some people also say that cooling down the must (near freezing) can help it clear. In other cases, it is possible to add fining agents which will flocculate (agglomerate) particles in suspension and make them drop to the bottom of the vessel.

Fining agents are of two kinds: some are positively charged and others negatively. Just like with magnets where north is attracted to south, positive attracts negative and they form agglomerates which eventually drop to the bottom of the vessel. Proteins for example being positively charged, one adds negatively charged particles (bentonite, silica gel) to flocculate them. Yeast cells are negatively charged, so one adds positively charged particles (Sparkolloïd, gelatin, isinglass). When fining agents are added, mead should become more limpid and all the stuff in suspension should become part of the lees (sediments). Rack a few weeks later to remove the lees and then again if necessary. Some fining agents like Sparkolloïd produce very light and fluffy lees which will go back up as soon as the carboy is touched or they will enter the hose even if it is one inch away from the lees.

The simpler and most natural fining agent is time. But if one is eager to bottle and drink quickly, fining can save time.  Also note that a mead which is not brilliantly clear (unless this is due to bacteria) will not hurt (see criteria of judgment in Syntheses).

# Bentonite

| Origin: | Aspect: | Charge: |
|---|---|---|
| Wyoming clay [V2, V5] | granulates [V1] | – [V2, V3, V5, V9] |

**Effect:**

Removes proteins from white and rosés wines [V2, V9]

Sometimes, clarification of cloudy fruit wines [V2]

Removes colloids, phenols, cloudiness-causing proteins, tannins [V5]

**Used along with:**

Gelatin or kieselsol [V5]

**Dose:**

Dissolve in boiling water and then let sit for 30 min [V5], 24 h [V1, V2, V6].

1 g/gal: general clarification [V2]

2 g/gal: removes proteins from white wines [V2]

1,5 g/L[V6], 1-2 g/gal[V3], 5-10 g/gal[V4]

½ tsp (2,7 g)/5 gal [V9] or 2 tsp (11 g)/5 gal [V9] if at the time of 1st racking (lots of lees)

**When:**

End of 2nd fermentation (where there are a lot of lees) [V5]

**Duration:**

24 h then 2-3 days to compact lees [V5]

**Most suitable for:**

Dessert wines [V6]

White wines [V9]

**Comments:**

If > 2 g/gal: loss of flavor [V2]

Lots of light fluffy lees [V2, V4, V5, V6, V9]

Removes color from red wine [V6, V9]

Benign [V9]

More efficient at room temperature [V9]

# Kieselsol (silica gel)

| Origin: | Aspect: | Charge: |
|---|---|---|
| | liquid [V5] | - |

**Effect:**

Removes proteins [V2, V3]

**Used along with:**

After gelatin [V2, V5]

Bentonite and gelatin-> compact lees [V3]

**Dose:**

1ml per g of gelatin[V2, V5]

0,3-0,5 g/L[B2]

1 ml/gal [V9]

**When:**

**Duration:**

Several weeks [V5]

1 week-10 days [V2]

**Most suitable for:**

White wine [V5]

**Comments:**

Selective: removes only not-nice proteins [B2]

Use small amounts=> pb measuring accurately [V2, V5]

Good replacement for tannins when used with gelatin [V9]

Limited shelf life (1 year or so) [V9]: do not keep stocks.

# Casein

| Origin: | Aspect: | Charge: |
| --- | --- | --- |
| Milk protein [V2] | Potassium caseinate [V2] | + ? |

**Effect:**

Removes phenols (tannins, oak) [V2, V9]

Sometimes removes some unwanted color from rosé [V2]

Often removes browning from oxidized whites wines [V2, V9]

**Used along with:**

**Dose:**

1/4 g/gal: removes browning [V2]

1/2 g/gal: removes bitterness/excess of oak flavor [V2]

1 g/5 gal [V9]

**When:**

**Duration:**

1 week-10 days [V2]

**Most suitable for:**

White/rosé [V2, V9]

**Comments:**

Reacts with acids => must be injected under pressure [V2, V9]

Excess -> cheese odor [V2]

# Isinglass/Biofine

| Origin: | Aspect: | Charge: |
|---|---|---|
| Protein (collagen [B2]) from the swim bladder of sturgeon [V2, V5, B2] | Powder/fragments [V5], granulates [V2] | + [V9] |

**Effect:**

Removes yeasts [B2]

Removes yeasts, tannins [ ??]

Exhausts flavor [V2]

**Used along with:**

Tannins [V9] (1/4-1/2 tsp /5 gal)

**Dose:**

Dissolve in 1/100 of the volume of must (200 ml for 5 gallons) and refrigerate for 36-48 h before use.

50-300 mg/gal(generally 100 mg/gal) [V2]

10-15 mg/L[ ??]

15-70 mg/L[V3, B2]

**When:**

**Duration:**

**Most suitable for:**

White wine, Champagne [V2, V3, V9]

Red wine [V5]

Rosé [V9]

**Comments:**

Little risk [V5]

Expensive [B2]

# Sparkolloid

| Origin: | Aspect: | Charge: |
| --- | --- | --- |
| Polysaccharides scattered in diatomic earth [V2, V5] | Powder | + [V5]<br>– [V9] |

**Effect:**

Removes , tannins [V5]

Removes proteins [V9]

**Used along with:**

after bentonite [V2]

followed by isinglass or cold stabilization to cover lees and keep them at the bottom [V9]

**Dose:**

1/4 g/gal: after bentonite [V2]

1/2 g/gal: clarification of whites wines [V2]

1 tsp / gal [V9]

**When:**

Fermentation done, beginning of aging [V5]

**Duration:**

**Most suitable for:**

White, rosé [V2, V9]

Red wine [V5]

Best product for mead [V5]

**Comments:**

benign [V2, V9]

fines lees, goes down slowly [V2, V9]

# Gelatin

| Origin: | Aspect: | Charge: |
| --- | --- | --- |
| Protein (collagen [B2]) from animal bone, skin, etc. [V5] | | + [V5, V6, V9] |

**Effect:**

Removes yeasts [V5], tannins [V2, V3, V5]

Exhausts taste [V3]

**Used along with:**

Kieselsol => good redeposition => quick [V2, V5]

**Dose:**

Mix 10-20 g [V2]/ 15 g [V5] in 1 L (1 qt) of hot water [V5]. Do not boil [V2]

1/8 g/gal: clarification of whites wines [V2]

1/4 g/gal: reduces bitterness of whites wines [V2]

1/2 g/gal: reduces tannins in red wines [V2]

0,5-1 g/gal[V3], 30 mg/L[V1], 60-90 mg/L[B2]

**When:**

Before 1 year [V3]

**Duration:**

3-6 days [ ??]

**Most suitable for:**

White, rosé [V2]

Troublesome red wines [V5]

Bitterness and astringency in red wines [V2]

**Comments:**

Be very careful: it can remove some flavor [V2]

May 29th 2002

# Sulfite ($SO_2$)



It is a gas resulting from the combustion of sulfur. It has been used since antiquity (by Romans and Egyptians) to sanitize barrels.

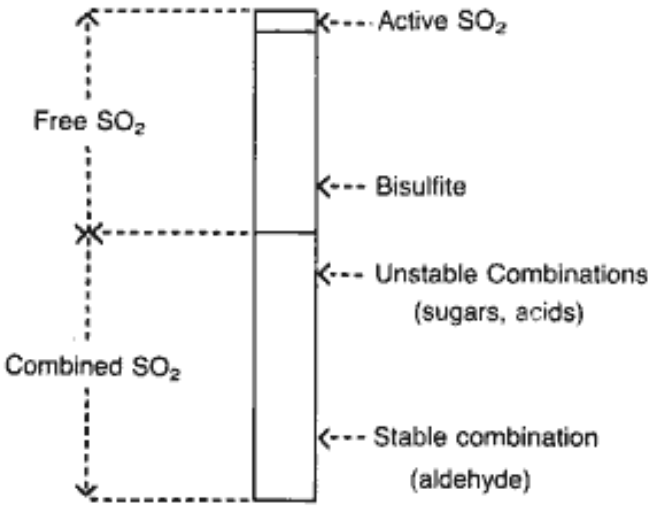
Added as sodium metabisulfite, both antiseptic and antioxidant, $SO_2$ is the working horse of winemakers. Some use it from the very beginning (to avoid heating honey) and then again at each racking. It is added at least at bottling to ensure the stability of mead during ageing.

The chemical equilibrium is [V6 p 202]:

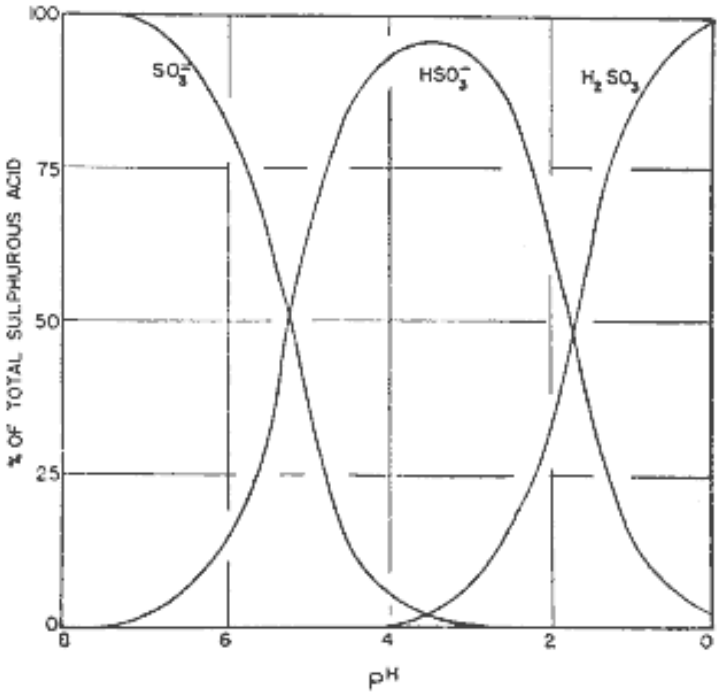
$$SO_2 + H_2O <-> HSO_3^- + H^+ <-> SO_3^{2-} + 2H^+$$

$$K_1 = 1{,}7\ 10^{-2} \qquad K_2 = 5\ 10^{-6}$$

One can notice that the quantity of $SO_2$ -- the only efficient form of the three (figure below, left) -- depends on the pH (figure below, right). If the pH is higher than 4, the efficiency of $SO_2$ is down to nothing. After the chemical equilibria above (using the law of mass action) or looking at figure 9, one can know how much free $SO_2$ is necessary to get some amount of active $SO_2$ (table).




*$SO_2$ can be under the forms of free $SO_2$ (including active $SO_2$) and combined $SO_2$ [V4]*




*Concentration of active sulphite (called $H_2SO_3$ here) as a function of pH [V6]*

One can notice that at a pH of 4, ten times as much sulfite is necessary to get the same result as when the pH is 3. In order to dose $SO_2$ properly, the pH must be known. If it is not we are likely to add 2-3 times as much as necessary or not enough. Some recipes say to add such quantity of sulfite without saying anything about pH. Such a number is almost worthless. Unfortunately, when one does not have a pH-meter, there is no other choice. pH paper is quite cheaper than a pH-meter but it is not precise enough to be of real use.

| pH | free $SO_2$ | active $SO_2$ / free $SO_2$ |
|---|---|---|
| 3.0 | 181 | 5.52 % |
| 3.2 | 282 | 3.55 % |
| 3.4 | 442 | 2.26 % |
| 3.6 | 700 | 1.43 % |
| 3.8 | 1116 | 0.90 % |
| 4.0 | 1795 | 0.56 % |
| 4.2 | 2918 | 0.34 % |

*Free $SO_2$ to use to obtain 1 ppm of active $SO_2$ as a function of pH.*

Sulfite must be kept in a dry place, away from air. Its efficiency decreases when it gets old. Note that some people do not tolerate $SO_2$.

White wine needs 15-20 mg/L of free $SO_2$ and sweet white 40-50 mg [Peynaud in V4].

References : Peynaud in V4 (chapter 6), chapter 6 of V2.

May 28th 2002

# Other chemicals



## Nutrients

In the introduction, we have seen that yeast turns sugar into alcohol. Honey provides this sugar. But yeast needs other nutrients on top of sugar: nitrogen, minerals, vitamins. Honey provides some of these nutrients. Darker honeys generally provide more minerals and nitrogen. But, in general, we add additional nutrients: nitrogen in the form of diammonium phosphate, urea or amino acids, magne-sium sulfate and vitamins can also be added. For ecologists, it is possible to decide not to add chemicals, but then fermentation is not reliable. One sometimes has to choose between poor diet and chemical diet. Fruits can also be added to provide nutrients (see adding fruits).

Berry and Brown describe in detail the nutritive needs of yeast [B10]. H11 describes various experi-ments of mead fermenta-tion with various combinations of ammoniated compounds and vitamins.

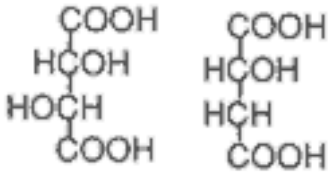
What amount to add?

Follow the directions on the box. Are they reliable? Hard to say, they must be suitable for wine or beer where the need for nutrients is not so critical. Unless the weather is awful, it should not be necessary to add nutrients to make wine. But, as far as mead is concerned, a fair amount of nutrients come from what we add. Does the seller overestimate quantities so that yeasts receive more nutrients than they need so

that fermentation is as fast as possible in order to prove how efficient their stuff is?

## Acids

Commonly used are tartaric, malic and citric acids. They are not related to honey and it is not sure that they are the most suitable ones but they are the acids of grape, and so they are the ones everybody uses (copycat).




*Tartaric and malic acids*

Tartaric acid is the main acid of grape. It can react with K+ ions (potassium) and form potassium bitartarate (cream of tartar) which will fall to the bottom of the bottles if they are cooled (see crystals).

Malic acid is mainly found in apples, peaches, pears, etc. [B3]. Some yeasts and bacteria can metabolize it. Malo-lactic fermentation, due to bacteria, turns malic acid into lactic acid (sensory threshold: 400 p.p. m. [B10]). Lactic acid being less acidic than malic acid, the result will taste less acidic. This phenomenon is used to improve the quality of acidic wines.

Citric acid is found in citrus, cherries, etc. It can be metabolized (consumed) by yeasts. It is therefore likely that citric acid added at the beginning of fermentation will have vanished at the end of fermentation.

See also addind acid in Syntheses.

Tartric acid is harsher, malic is greener and citric is fresher [Mowbray in V4]. Malic acid is slightly less sour and is a bit fresher tasting than tartaric acid [V9].

## Vitamin C

Vitamin C (ascorbic acid) is an antioxidant. It is not used instead of sulfite which is also an antiseptic, but it allows to reduce the amount of $SO_2$ to be used. Vitamin C is never used without $SO_2$ [V4, V6].

The legal limit in France is 100 mg/L but there is hardly a limit in the U.S. [V4].

## Sorbic acid

It is a non-toxic non-saturated fatty acid. It prevents yeasts from multiplying and from refermenting sugar but does not kill them [Peynaud in V4]. It is used to prevent the fermentation from restarting in sweet meads. In many countries, adding of 200 to 300 mg/L of sorbic acid is permitted [V6], the

maximum is 200 mg/L in France [V4] and 1000 mg/L in the US [V6]. The sensory threshold is 135 mg/L [V6].

Its action is reinforced by [V4]:

- the presence of alcohol (3 times as much sorbic acid is necessary at 20 proof as at 28),
- a low pH (the efficiency doubles between a pH of 3.5 and of 3.1 and at a pH above 3.5 the legal limit is insufficient),
- the presence of $SO_2$.

Solubility of sorbic acid in water being low, potassium sorbate is used instead. 270 mg of sorbate give 200 mg of sorbic acid. It is added slowly to the mead (which must contain only few yeast cells), with a vigorous agitation [V4]. See also geranium smell in A problem?.

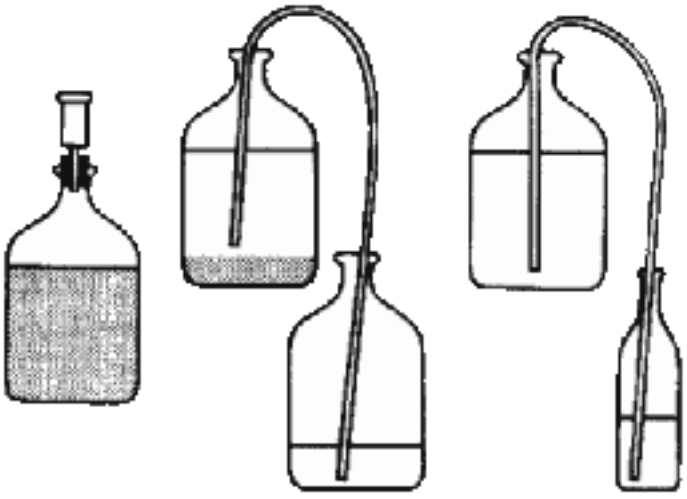
| | anti-oxydant | antiseptique | inhib. ferment. |
|---|---|---|---|
| sulfite | X | X | |
| vitamine C | X | | |
| sorbate | | | X |

*Use of $SO_2$, vitamin C and sorbic acid*

May 28th 2002

# Mead recipe





*Steps of mead making: fermentation, racking, bottling (after [V1])*

There are many recipes to make mead but they all involve more or less the same steps. The general procedure to make mead is presented here while variations (using fruits, making sparkling mead, etc.) are preseneted elsewhere. The first steps of the "recipe" involve the preparation of the equipment and of

the yeast. Then the fermentation is actually started. When it is done the mead can be racked, then bottled and aged.

- Preparation What you must do before you make mead
  - Equipment sanitation
  - Starter
- Fermentation The process by which the yeast makes mead from the honey.
  - Fermentation
  - Fining
- Time to bottle When the mead is ready...
  - Bottling
  - Aging
- Why the speed of the fermentation is important
- The importance of fermentation temperature
- Alcohol content as a function of intial and final gravities (pdf file)

June 9th 2002

# Speed of fermentation



Is mead better when fermentation is slower? Or is mead better when fermentation is faster? Some people, in the name of tradition, answer that fermentation must take time, whereas some other people prefer a faster fermentation. Whichever prejudice one has, it should be admitted that trying and answering this question using reasons other than "in the good old days..." or "I am in a hurry" would be better. The final result must be the only judge.

- A low temperature (do not exaggerate) will slow down the fermentation but it will also modify the balance between chemical reactions and the proportions of various products (and therefore the taste).
- Agitation scatters yeast cells, so they are more efficient (ferment faster). But this also drives off some volatile organoleptic compounds one may prefer to keep in the mead [V2].
- Some strains of yeast are intrinsically faster than others. But differences in the final result will depend more on other differences between yeasts than on the difference of fermentation speed.
- If fermentation lasts too long, autolysis can take place and modify the taste.
- If fermentation lasts too long, the must will also spend some time containing some sugar and little alcohol, which is a perfect environment for the development of bacteria.
- Slowness of fermentation can also be a sign of bad health of the yeast or of some handling

mistake (see stuck fermentation in A problem?). In such a case slowness is a bad sign.

- On the other hand, if fermentation is made faster by adding excessive nutrients, mead will need a long ageing time to get rid of the nutrient off-flavor. The few days of fermentation time spared this way will be reimbursed later at a credit card rate.

One can therefore notice that there is a link between speed of fermentation and quality of mead. But no over-simplification. In order to say whether slow or fast fermentations are better, it is necessary to know the cause of such a speed. Generally speaking, the speed itself is less important than some cause that will modify both the speed and the quality.

May 28th 2002

# Fermentation temperature



This is an obsession of beer brewers. Books on beer thoroughly explain temperature cycles to be used for every kind of beer. (The craze of wine makers seems to be pH and moreover sulphite). As far as wine is concerned things look simple: cold for white (15-20°C/60-70°F), and warmer for red (25°C/80° F). Concerning mead... recommended fermentation temperatures vary greatly. Generally speaking, when in doubt wonder what is done to make white wine. It can help get an idea. So 15-20°C (60-70°F) it is.

What is the influence of temperature? If the temperature is low (but not below 15°C/60°F unless you have something special in mind and a suitable strain of yeast) fermentation will be rather slow. But this will also modify the balance between chemical equilibria, that is, proportions of various organoleptic compounds produced during fermentation will be different at different temperatures. And so will be the taste.

Fermentation is exothermic (it produces heat). If the vessel is small enough (high surface to volume ratio), heat will be easily dissipated. Otherwise, temperature must be monitored or else it may rise too much. This is especially true at the beginning of fermentation, when it is very active.

Except in some cases, some fortified wines for instance, temperature must be kept as stable as possible.

May 28th 2002

# Embedded Secure Document

The file *http://www.meadmadecomplicated.org/mead_making/procedure/alcohol_content.pdf* is a secure document that has been embedded in this document. Double click the pushpin to view.

# Mead recipe I: preparation



## Sanitation of equipment

It helps get rid of bacteria and wild yeasts. The lack of cleanliness of equipment is considered by many people as the main cause of bacterial problem (one could argue that this is a pretext not to say "I have no clue why there is such a problem".)

Wash everything (carboy, vessel for the starter, rubber stopper, spoons, thermometer, hydrometer, funnel) with soap water, then rinse.

Soak in cold water with bleach for a few hours. Rinse with hot water until no bleach odor remains (bleach would kill yeasts.)

Some products exist which do not need rinsing. Some people use their dishwasher.

# Starter

It is to banish bacteria from the must (water-honey mixture, not fermented yet or fermenting) that a starter is prepared. Which means that yeasts are not directly dropped into the must, they are first allowed to respire in order to store energy and multiply before starting fermentation [H10]. Yeasts can multiply and they will produce alcohol faster, which kills wild yeasts [H9]. Do not add any sulfite, as it would kill the yeasts.

Boil 1.5 qt of water for 10-15 min and then add ½ pound of honey and let it cool down. When the temperature is as low as 100°F, pour in a 2 qt vessel and add 2 ½ tsp of nitrogen-containing nutrients (use lower quantities with honey containing more honey than average and higher quantities for honeys lower than average) and ½ tsp energizer (vitamins). Mix well and add yeast (quantity for 5 gallons).

Dissolve some sulfite in hot water. Soak a cotton disk in it and dry the cotton squeezing it between your hands (wear gloves). Shake gently the yeasts and put the cotton on top of the vessel. This should prevent bugs and dust from entering the starter, while allowing air to come in and provide yeasts with oxygen. $SO_2$ should repel bacteria. Let sit for 30 min, maintaining the temperature around 100°F (place the vessel in warm water) without stirring (this would damage cell walls which are still weak at that time [Lalvin]) then stir again. Agitate from time to time until the fermentation is vigorous. This is short with dry yeasts but can take days which liquid forms which are a bit old, in such a case see maker's directions). Use at the peak.

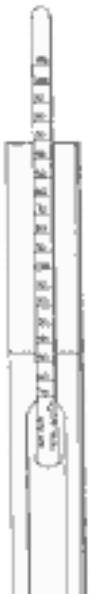
June 6th 2002

# Mead recipe II: fermentation



## Must

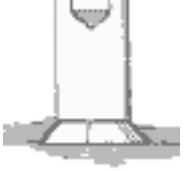
*Hydrometer indicating 1,145 [F3]* →



Boil 2,5 gallons water to remove the chlorine it contains, let cool and pour in the 5 gallon carboy (boil twice 1 ¼ gallon if this is more convenient). This can be done ahead of time -- the day before or while preparing the starter.

Boil 1 gallon water for 10-15 min to remove the chlorine. Reduce the heat to low and add 12 pounds of honey (around 1 lb of honey per gallon per 10 proof). Maintain at 150°F for 5 min [M1 p. 513] in order to « pasteurize » honey. Due to its pH, its hygroscopy and its hydrogen peroxide, honey is not a good candidate for a bacterial infection, the main hazard are wild yeasts [H4]; so it is not necessary to boil it, boiling would drive off some flavor. (See also sanitation in Syntheses). Remove the foam (it is made of protein which would make a haze in the mead). Cool down in the sink filled with ice. In the mean time, boil 1 gal

water to remove chlorine and let it cool down. When the must is below 100°F, pour it into the carboy and add the starter. Then add water to make 5 gallons (or less if you plan to add honey later).



Homogenize the must and take a specific gravity (S. G.) measurement (figure on the right), it should be around 1,09-1,10 (it should lead to 25 proof). Take a sample and measure its pH.

Add the stopper and the air-lock (add some sulfite in the water to repel bacteria).

## Fermentation

This step takes several weeks at 70°F (ideal temperature depends on the kind of yeast but in general high temperature are to be avoided, fermentation would be faster but the quality would be lower). (See also temperature in Synthesis). Do not shake the carboy as this could drive off volatile organoleptic compounds and modify the taste [V2] (this increases the speed of fermentation though, because yeasts at the bottom of the vessel are less efficient).

If a dessert mead (sweet and with a high alcohol content) is what you want, it is necessary that the initial S. G. be high (1.12 or 1.15). This may inhibit the fermentation, as yeasts do not like to have too much sugar at once. It may be a better idea to have an initial gravity (I. G.) of 1.08 or 1.10 and then add more honey after a week or so. When honey is added, it is safer to weigh it and extrapolate the change in density rather than use the hydrometer. Honey will not be well mixed immediately and the gravity will be under-estimated (even if the carboy is shaken and the must looks homogeneous).

The fermentation is done when the number of bubbles becomes very low. That is, when there is no more sugar or the alcohol content is no longer withstood by the yeast. It is also possible to choose to stop the fermentation before it is over, generally if a rather sweet mead is seeked. In this case extra care is necessary to prevent the fermentation from restarting (see sorbic acid in Chemicals).

The mead must not be left on the lees (especially when the weather is hot) lest the yeast will feed itself of them (autolysis) giving a bad taste [H2, h2].

## Racking

← *Racking [V1]*

Sanitize a new carboy, a rubber stopper, the hose, the funnel and the hydrometer. Boil ½ qt water to remove chlorine and let it cool down.

Place the new carboy lower than the first one. Hold the hose with one hand, both ends up and at the same height. Fill it entirely with water and stop one end (use the hand holding the hose). Remove the stopper and the air-lock. Place the free end of the hose in the carboy that contains the mead (be careful if the carboy is full) and then the other end in the new carboy. Siphon mead to the

second carboy leaving lees in the first one (see figure). The hose must be at the bottom of the second carboy to avoid splashing, and therefore aerating, the mead (avoid oxidation).

If some air gets into the hose and the process stops, start over.

Take a S. G. measurement. Take a sample, taste it then measure its pH. If necessary, add some water so that the liquid in the carboy is close to the stopper (5 mm) as the less air the less oxidation. Put the air-lock back on.

### Air

Air brings in essentially two things: oxygen and bacteria. Bacteria are not something we are looking for (apart for the malo-lactic fermentation of wine). Oxygen, on the other hand, can be welcome or not, it depends. To start fermenting yeasts need energy, they get this energy from respiration, which requires oxygen. But then oxygen must be banished from the must, because mead -- if it behaves the same way white wine does -- is very sensitive to oxygen and will oxidize easily (browning, bitterness): see oxidation in A problem?

## Clarification

Maintain around 60 °F and rack as many times as required (in general the second racking takes place two weeks to one month after the first one, then rack every two months or so; it is pointless to rack if there are no new lees). Taste the mead each time you rack. If the taste is too flat, add some acid in a small sample (not in the whole batch). If the taste is improved, add acid to the whole batch. This can be done in several steps, adding little acid at a time to avoid adding too much.

If the temperature is lower than the fermen-tation temperature, check the airlock because the contraction of mead and air due to the drop of temperature can drive some of the water of the air-lock into the mead. If rackings take place at room temperature and the mead is then stored at a lower temperature, the level of the liquid must be close to the stopper within a few millimeters because the contraction due to the decrease of temperature will increase the air space. So if there is 5 mm at the beginning, there could be almost 1 cm at lower temperature. Also check that enough water remains in the airlock. Add some if necessary, for an empty airlock is absolutely useless and the mead can be lost quite fast.

Bulk ageing lasts 3 to 6 months for light white wines and fruit wines, 6 months to a year for other white wines and light reds [V5]. Mead should be somewhere between 3 months and one year. In any case the mead should not be bottled before it clarifies and above all before the fermentation is over (if the mead is bottled too early, the fermentation could restart and bottles explode.)

What if the mead is not good? Either it is too young (can improve) or it is just bad [H13]. A batch which is not satisfactorily and may never be so should not be bottled. If some ageing seems necessary, let the mead bulk age until it prove good before bottling.

If the mead does not spontaneously clarify in a few months, fining agents can be added to speed up the process and rack until the mead can be bottled. Given the ageing needed for mead, it is pointless to hurry

up and to want to bottle right after the fermentation stops. On the other hand, if mead really does not clarify, fining is an option which should not be refused *a priori*.

Before bottling, add sulfite to ensure the stability of mead during ageing.

Reference: chapters 14 to 16 in V2.

June 6th 2002

# Recipe III: bottling



## Blending

Some mead makers will add a dozen ingredients in their meads (fruits, species, etc.) but fewer seem to blend honeys. It is a great way of improving the complexity and the balance of a mead though. This is commonly done with wines where several kinds of grapes are used (e.g. cabernet sauvignon and merlot for red Bordeaux; pinot noir, pinot meunier and chardonnay in Champagne.) This allows to balance flavor (and cost.)

Some honeys have a very strong flavor which can be overpowering or boring: buckwheat, orange blossom. Orange blossom mead has a great flavor but is very one-dimensional. Buckwheat mead is very strong and buckwheat is likely to kill any other flavor. It can therefore be a good idea to try to blend those with more neutral (and cheaper) honeys such as clover or wild flower.

Another purpose of blending is to match up flavors. As you can use several fruits in melomels or use fruits and spices to get the right taste, you can blend honeys that have noticeably different flavors:

orange blossom, buckwheat, tupelo, berries, etc. I currently have 8 batches fermenting, each with a different varietal honey; I plan on blending them within a few months and see what I like.

Why add fruits and spices when there is such a variety of flavors in honeys themselves?

Another use of blending is when one batch is problematic (too dry, fruit or spice taste too strong, honey too strong, too much acid added, etc.) But waste is waste: adding a little vinegar to a fine mead just gives a lot of vinegar. Keep in mind that some problems can be solved by blending and some others cannot. In any case blend and taste small quantities (do not do this alone to get several points of view) before blending larger quantities (about a gallon) and ageing for a few months to see how the batches interact.

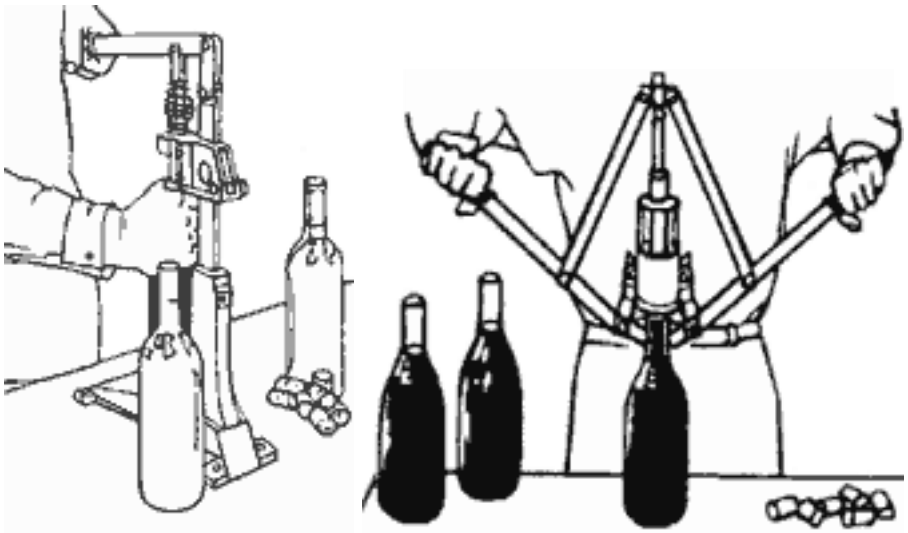
## Bottling

← *Filling the bottles: there is too much air space in the left bottle [F3]*

It is not mandatory... But if one does want to bottle, do as for rackings, siphoning mead from the carboy to the bottles. Leave only half a centimeter of air space between the mead and the cork to reduce oxidation.

Cork the bottles using a new cork. It is possible to recycle used bottles if care is taken to sanitize them properly (after any solid matter is removed, proceed as for carboys). Brown glass is more protective but does not look that great. Recycling green glass wine bottles seems to be a good compromise.

Nowadays, plastic can be used instead of cork. These "plastic cork" seem to be less elastic and therefore harder to use. In a comparison, V9 found that some plastic ones have much poorer results than cork or beer caps. But they are new, so they can be expected to improve quickly and perhaps V9's comments are already out-of-date.



*Bottling [V1]*

References: chapters 7 in V9 and 17 in V2.

# Ageing

A half dozen years should suffice. To do this, a lot of mead (really a lot) must be made, so that it is impossible to drink everything when it is still young. So a part of the mead made can age.

Bottles are stored horizontally (to prevent the cork from drying) in a room with an average humidity: too dry and the corks dry and leak, too humid and bacteria can grow. If wine bottles and corks are not used (this can be done is mead is not to be aged and will be drunk soon), it is not always necessary to take some much care of humidity or to keep bottles horizontal, this can even be to be avoided is the (metallic, rubber, etc) stopper can harm the taste of the mead. Bottles are aleways stored in a dark room at a steady temperature between  10 and 15°C (50 and 60°F).

June 6th 2002

# Mead recipes



- Mead types Different styles of mead, what can be added to mead
- Adding fruits When and how to add fruits to mead to make melomels
- Sparkling mead Make sparkling mead using the 'méthode champenoise'
- Make an original mead suing the technique to make Sherry

## Distillation

It is possible to distillate mead to make brandy using the liquid-vapor transition (using an alambic) or the liquid-solid transition (freezing the mead).

Weakness: Whichever method is used, distillation is illegal. F8 also explains that distillation will concentrate not only ethanol but also methanol (toxic).

May 28th 2002

# Types of mead



## Naming mead

Anything can be added to mead: herbs, spices, fruits, etc. Some people even advise not to start with a traditional mead as the one described above. Instead they advise to add spices that can hide weaknesses of the mead if necessary.

| name | synonym | herbs/spices | fruits | others |
|---|---|---|---|---|
| show mead | | | | |
| traditional mead | | little* | little* | |
| bochet | | no | | high S. G., burnt or charred |
| bracket | ± braggot | | ale | |
| braggot | ± bracket | | malt | |
| capsicumel | | | pepper | |
| clarre | pyment | | grape | |
| cyser | | | apple | |

| | | | | |
|---|---|---|---|---|
| hippocras | | yes | grape | |
| hydromel | small mead | | | low S. G. |
| melomel | mulsum | | fruits other than grape/apple | |
| metheglin | | yes | | |
| morat | | | mulberries | |
| mulsum | melomel | | fruits other than grape/apple | |
| oxymel | | | wine vinegar | |
| pyment | clarre | | grape | |
| rhodomel | | | distilled rose petals | |
| sack | | | | high S. G. |
| small mead | hydromel | | | low S. G. |
| T'ej | | | hop | |

*Table: names for some mead styles. * means that honey flavor must dominate*

Spices and herbs that can be added to mead: ginger, cardamom, cloves, vanilla (?) [Gayre], thyme, rosemary, bay leaves, sage, parsley, fennel [hist2] but also cinnamon, nutmeg, lemon or orange peels, etc.

# BJCP categories

The following taxonomy is from the beer judge certification program (bjcp.org.)

## A. traditional mead

### Description

Made from water, yeast and a blended honey (wild flowers) or a blend of honeys. For meads made from a single variety of honey see below "B. varietal honey traditional mead."

### Flavor

Honey aroma should dominate, which may be sweet and may express the aroma of flower nectar. Aromas produced during fermentation, such as fruity esters and alcohol, may also be present. The flavor of honey should be featured and may include residual sweetness. Any additives, such as acidity or tannin, should enhance the honey flavor and lend balance to the overall character of the mead.

### Other characteristics

Color may range from pale straw to deep amber depending on honey used.

## B. varietal honey traditional mead

### Description

Same as traditional mead but made from honey from a particular flower source.

### Flavor

Same as traditional mead plus: the distinctive flavor of the nectar honey is made from must be evident (it is the flavor of the honey not that of the fruit, orange blossom for instance doe not taste like oranges.)

## C. cyser

### Description

A mead made with the addition of apples or apple juice. Traditionally, cysers are made by the addition of honey to apple juice without additional water.

### Flavor

Should have distinct apple character with a pronounced honey aroma, which may be sweet and may express the aroma of flower nectar. The Apple character may supply tart acidity to cut the honey sweetness, so one may notice tart acidity first and residual sweetness thereafter. In well made examples of the style, the fruit is both distinctive and well-incorporated into the sugar-acid balance of the mead. Some of the best examples have the taste and aroma of an aged Calvados (apple brandy from northern France).

### Other characteristics

There should be an appealing blend of the fruit and honey character but not necessarily an even balance. Generally a good tannin-sweetness balance is desired, though very dry and very sweet examples do exist.

## D. pyment

### Description

A mead made with the addition of grapes or grape juice. Alternatively, the pyment may be a grape wine sweetened with honey, a mixture of grape juice and honey that is fermented or a mixture of grape wine and mead mixed after fermentation.

### Flavor

Should have distinct grape wine character, manifested in acidity, tannin and other grape characteristics, but the honey character should balance the fruit flavors. Grassy white wine character or buttery (diacetyl) Chardonnay character is appropriate in pyment only. In well made examples of the style, the fruit is both distinctive and well-incorporated into the sugar-acid balance of the pyment.

### Other characteristics

Color would reflect the grape source, whether white, red or other.
There should be an appealing blend of the fruit and honey character but not necessarily an even balance.
Generally a good tannin-sweetness balance is desired, though very dry and very sweet examples do exist.

## E. melomel

### Description

A mead made with the addition of other fruit or fruit juices. There should be an appealing blend of the fruit and honey character but not necessarily an even balance.

### Flavor

Should exhibit the aroma of the fruit(s) present in the mead. In a melomel with a blend of fruits, one fruit may dominate. Fruit flavor contributions to the mead range from subtle acidic notes to intense, instantly recognizable fruit flavors. There should be a balanced honey character as well. In well- made examples of the style, the fruit is both distinctive and well-incorporated into the sugar-acid balance of the mead.

### Other characteristics

The particular fruit(s) used may or may not impart color to the mead.
Generally a good tannin-sweetness balance is desired, though very dry and very sweet examples do exist. Some fruits, notably darker ones like Blackberries, may contribute a tannin presence not unlike dark pyments

## F. metheglin

### Description

A mead made with the addition of spices/herbs/petals.

### Flavor

The spices/herbs may be expressed in the aroma. Metheglins containing more than one spice should have a good balance among the different spices/herbs, though some spices/herbs will tend to dominate. The spices/herbs should be expressed in the flavor but the honey character is still the backbone of the mead and should appear in the flavor but will vary in intensity depending on the spices/herbs used. The spices/herbs should be expressed in the flavor as a distinctive enhancement to the honey flavor, whether harmoniously or by contrast, and should achieve a pleasant balance when a blend of spices/herbs is used.

### Other characteristics

The color usually won't be affected by the spices or herbs.

## G. braggot

### Description

Meads made with both honey and malt providing flavor and fermentable extract. Originally, and alternatively, a mixture of mead and ale.

### Flavor

Aroma of both honey and malt should be apparent and in balance. There should be some balance between the beer aspect and the mead aspect of a braggot, especially with regard to maltiness and bitterness versus honey character. Malt character ranges from light pale malt-type flavors to rich caramel flavors, depending on the malt used. Hop bitterness and flavor may be present but are not required.

### Other characteristics

Straw to dark brown depending on the type of malt and honey used.
Some head retention is expected.
The fermentable sugars should come from a balance of malt and honey, otherwise the beverage is a specialty beer with the addition of honey. Hopped examples of this style should exhibit the hops distinctly and should have at least 15 IBUs.

## H. mixed category

### Description

A mead that combines ingredients from two or more of the other mead sub-categories.

### Flavor

Aroma, appearance, flavor and other characteristics may vary and be combinations of the respective elements of the various sub-categories used in this style.

### Other characteristics

This mead should exhibit the character of all of the ingredients in varying degrees, and should show a good blending or balance between the various flavor elements.

## Other properties

In each of these categories, meads can be:

- sparkling or still.

- dry, semi-sweet or sweet. It is hard to know where the limits are between dry and semi-sweet and between semi-sweet and sweet. The limit between dry and semi-sweet has something cultural to it: a sudy showed that to French people a dry white wine has 2 g of residual sugar per liter and semi-sweet wines have 8-10 g/L; to Germans, a white wine containing 12-15 g/L is dry and it is semi-sweet at 16-20 g/L.

# Discussing categories

## Why are there categories in the first place?

There are two purposes:

1. Tasting similar meads together. It is easier to compare things that taste alike. Imagine that you are asked to rank different oranges or different apples. Now imagine that you are given oranges and apples and asked to determine which of these is the best. Categories are there precisely to avoid comparing apples to oranges.
2. Comparing the merit of mead makers. In sports there are categories: men/women, age for kids, weight in combat sports, etc. Beating somebody who is younger and lighter does not make you a champion.

## "In terms of tastes"

In "a treatise on mead judging", Michael L. Hall writes "In the 1992 Mazer Mead Cup the winning traditional mead contained small quantities of tea [...] The organizers of the Mazer Mead Cup changed the categories in subsequent years to include both a traditional mead, which allowed other ingredients, and a show mead, which only allowed honey, yeast and water. I think that a better solution would be to define the category in terms of tastes, rather than ingredients." If categories are set "in terms of tastes", tupelo is floral and tupelo mead should belong in the 'metheglin' category then (i.e. the floral/spicy category.) Categories could be renamed:

- 'honey' (formerly called 'traditional' or 'show'),
- 'spicy/floral' (formerly known as 'metheglyn'),
- 'fruity' (old 'melomel'),
- 'malty' (ex-'braggot'),
- 'mixed'

This would be interesting because it would allow to taste together meads similar in taste (purpose 1.) However if two meads achieve the same result through different techniques, who should win (purpose 2)? From a practical point of view, it would be hard to know in which category a mead belongs.

## 'Show mead'

Concerning the 'show mead' and 'traditional mead' categories, Michael L. Hall writes in "a treatise on mead judging": "I think that a better solution would be to define the category in terms of tastes, rather

than ingredients. A traditional mead would then contain any ingredients the brewer cared to use, but any spicy or fruity character would be considered a flaw." 'Show meads' can contain honey, yeast and water only whereas 'traditional meads' can have tannins or spices (for complexity only.) There is not a large difference between those and nobody is able to tell them apart without reading the recipe (otherwise the traditional has noticeable additions which is a fault.) But one could argue that those who get the same result without adding anything deserve more. Meads should compete with their peers.

### Varietal honey

Hall also argues that "a third problem is that meads that use an interesting varietal honey tend to get short-changed if the judge is not familiar with the type of honey. A mead made with strongly flavored and dark mesquite honey is a prime example of this problem. I propose that traditional meads that feature a varietal honey be judged separately." This would not be enough, as "in terms of tastes", varietal honeys vary greatly, so it would require an 'orange blossom' category, a 'buckwheat' category, etc. There is more difference between buckwheat mead and orange blossom meads than between show and traditional meads. I agree that it can be tough to judge special meads.

### Comparing the incommensurable

The main issue is that there are many kinds of mead and few entries. The traditional meads and melomels may be split into a few categories but this is not possible for other categories. So, because of the fairly small number of entries, most categories are very heterogeneous. I judged the 'open category' at the latest mazer cup (which included braggots), we had to taste an apple pie mead, a few braggots, a capsimel from hell, various meads matching a fruit and a spice. In order to compare them to something similar (which is the whole point of categories) there should have been six categories for these twelve meads. Comparing the incommensurable is an intrisincally impossible challenge.

### Sweetness

Sweetness is not used to determines categories. I think that this comes from the fact that categories have been established by beer brewers for whom this is not a major characteristic. In the case of the French concours général agricole, there are two categories for meads: sweet meads and dry meads. So sweetness could be used to create categories.

## References


- Beer judge certification program (bjcp.org.)
- M. L. Hall: "A Treatise on Mead Judging". Hall claims that current categories are based on historical reasons and that meads have their own category if they have a special name, whereas some more common meads lacking a special name do not have their own category. He then proposes new categories.
- Gayre G. R. : "Wassail ! In mazers of mead", Brewers publications (1986)

April 15th 2003

# Adding fruits



Freezing the fruits for a few days helps extracting the juice [H10, F1] by breaking cell walls [R7] more efficiently than a food processor could do.
Do not heat fruits, to sanitize them as is done with honey, because the pectin of the fruits may set and create a haze.

When to add them?

If they are added at the beginning, they will provide nutrients (decreasing the need for chemicals) and they allow a faster clarification.

The drawback is that a lot of taste will be gone with the wind of CO2. If fruits are added after the end of fermentation, the batch can be split into several batches, some with and some without fruits.

Another hypothesis is that fruits added at the beginning of the fermentation are merely fermented, so the result is not a mead-fruit juice mixture but a mead-fruit wine mixture. As we know wine does not taste like grape or mead like honey. Therefore, if the fruit is added when the fermentation got soft, it will not or not much be fermented and the fruit flavor will be preserved.

Some fruits contain tannins as those found in red wine. This will add some bitterness to the mead but they can be used to add complexity. They are found in the skin and seeds (cores should be discarded for some of them can be toxic). So adding the whole fruit or only the juice will modify the flavor of the mead [MLD 907].

May 28th 2002

# Sparkling mead

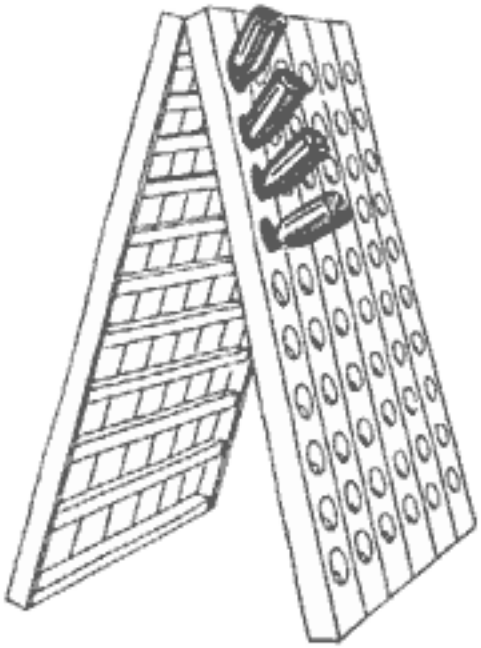


Usual fermentation using a strain of yeast that will give a very dry mead (for example Champagne yeast, saccharomyces bayanus, but this is not mandatory). The alcohol content must be between 10 and 11 % (20-22 proof). If lower, the $CO_2$ would not be absorbed and so there would be no bubbles. If higher the second fermentation may have troubles starting [V3]. It is therefore necessary to measure honey accurately and to use a reliable yeast.

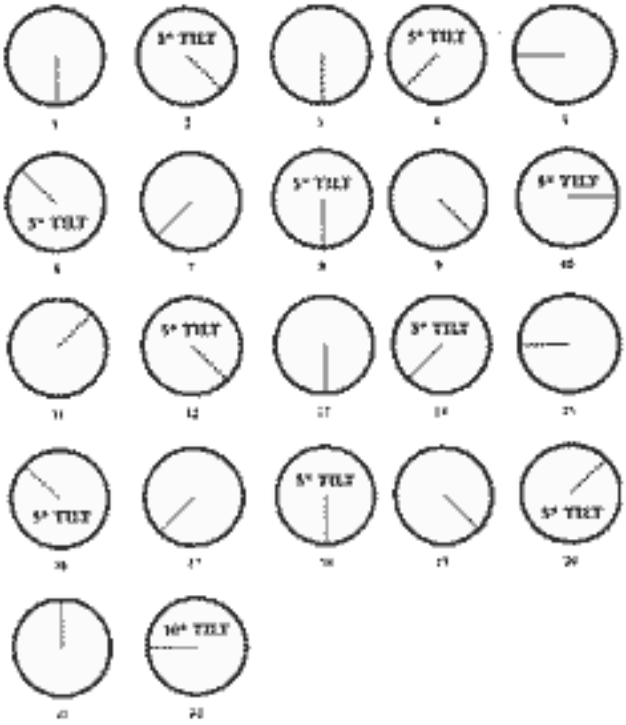
When the fermentation is done, rack as usual until the mead clarifies. Take must be taken to adjust the acidity, a lack of acid would reduce the complexity of the mead [V3]. Do not $SO_2$ when bottling because it would make the life of the yeasts harder during the second fermentation. When mead could be bottled, add yeasts, sugar and nutrients. 27 g of sugar per liter is the legal maximum in Champagne [V8]. Knowing that 4 g/L give 1 atm of pressure [V4], if too much sugar is added the pressure may be too high, which can be dangerous. V4 advises to hydrate them following maker's directions and then add some mead (less than 5 % of the batch) so that they get used to this hostile environment where they are about to go. The yeast must be a bayanus (Red Star Pasteur Champagne is not a Champagne yeast and cannot be used for the second fermentation). Get information from the maker to use the right yeast (Red Star Première cuvée or Lalvin EC-1118 for example).

Bottle immediately. As there is still sme sugar, the fermentation will restart. It is therefore mandatory to use bottles tolerating high pressure, that is Champagne bottles. In Champagne, bottles are capped with "bidule" (figure 16) to prevent any leak topped with a beer cap [V8]. "Bidule" means something like "thingy"*"bidule" [V8]* →

Bottles are stored on their side at a low temperature (ca. 10-12°C) so that the fermentation is not too fast: the slower the fermentation, the finer the bubbles. In Champagne, the second fermentation (or prise de mousse) lasts at least 15 months (legal minimum) but can last as long as half a dozen years. A change in taste happens after 2 years on the lies and another one after 4-5 years [V9].

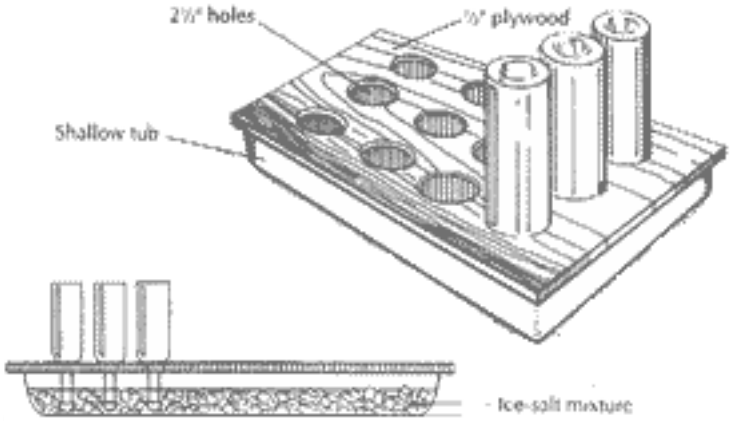


*Rack [V4]*



*Riddling scheme [V4]*

Lees will fall to the bottom of the bottle. To remove them, the bottle is more and more inclined (so that the neck goes down, left figure above) and "shaked" (following the scheme shown in the right figure above) so that the lees slip along the walls of the bottle and end up in the neck. This is called riddling (remuage in French). See V4 for more details about this. An alternative for those who do not want to buy or make such a rack: put bottles vertically, neck downward, in a box. Once or twice a day, raise the bottles by a few centimeters (an inch or so) and drop. The light shock is supposed to separate the yeast cells from the walls of the bottle [C. Dewitt Ward cited in V4].




*Freezing the lees [F3]*

Disgorging (dégorgement): store the bottles in the fridge (at a lower temperature, the pressure is also lower and the process will be less explosive) then place them upside down with the neck in a mixture a crushed ice and salt to imprison the lees in ice (figure 19). When the bottle is the opened, lees are pushed away by the pressure (the bottled should be directed toward something that will stop projectiles and avoid hazardous bounces, and do not forget to be properly protected when doing this.) Quickly clean the inside of the neck and add some "liqueur de dosage" (alcohol, sugar, 20-25 ppm $SO_2$) to top the bottle

(dosage). Depending on the amount of sugar added, the mead is brut (< 15 g/L), dry (17-35 g/L), demi-sec (33-50 g/L) or sweet (> 50 g/L). Cork immediately the bottle with a mushroom cork if you have the equipment (or else use a plastic mushroom) and tie with a metal wire. Beer caps can also be used.

In order to let the mead "se rasseoir" (which literally means "sit down"), that is forget about the trauma of dégorgement and let the liqueur mix well, the bottle is left upright for several months before aging or drinking.

References: Gifford in V4 (chapter 5), chapters 9 in V3, 11 in V6, 13 in V9, chapter 20 of V2, F3.

May 28th 2002

# Sherry-style mead



Make sherry out of mead? Why not, some do that with wine.

It is a fermentation that is partly aerobic. It is one of the few cases when wine is aerated on purpose. A yeast that will produce a flor must be used (*saccharomyces fermentati* sold for instance by Red star).

After a first fermentation as usual, the must is pitched with the flor yeast and exposed to air. The mead must have reached 14 or 15 % alcohol at the end of the first fermentation: if less the exposure to air would be a suicide because of bacteria, if more the yeast may suffer. In some cases (nobody knows why it sometimes happens and sometimes not) a flor will develop, that is a thin solid layer will form at the surface. Wines having such a flor are thought to be better. The time of exposure depends on the taste one is looking for.

Spanish use the *solera* system: they us numbered barrels and every year, they bottle half the content of the first barrel and pour half the content of the second barrel into the first one, half the third barrel into the second one, etc. They use the wine they have just fermented to fill the last barrel. So the new wine "learns" from the older one. If there are ten barrels, the wine bottled is at least ten years old, but *a priori* some of the wine is as old as the winery!

References: chapter 5 in V4 (Knap, Cooper, Roesener), chapter 9 in V3, chapter 9 of V6.

May 28th 2002

# Troubleshooting



It is not easy to know what the potential problems are, what they are due to, how to prevent or solve them.

There are books on wine and beer dealing with possible troubles but some of them are specific to these beverages. As far as mead is concerned, there can be no problem due to sulphating (bees are not allowed to sulphate honey), or to pathologies of malt or hops. So we can rejoice because mead may be less at risk than beer or wine. The other face of the coin being that there are few sources of information addressing problems that can happen during the making of mead. So beer and wine literature will have to do, we have to guess whether some pathology can hit mead or not.

When one thinks there is a problem, one should ask several questions:

- Is it normal? That is unexpected for sure but does it mean it is abnormal?
- Is it troublesome? If the symptom is not a problem in itself, one has to determine whether its cause is problematic or not. If the mead is cloudy because of proteins or yeasts, that is no big deal. On the other hand, if it is because of bacteria, action is to be taken right now. The symptom can sometimes be worse than the cause: if bottles explode, no need to wonder what it is due to, something has to be done anyway.
- Is there a solution to this problem? If so, are side effects more problematic than the problem itself? See criteria of judgment in Syntheses.

# Different kinds of problems

- Stuck fermentation
- My mead looks funny
  - Oxidation
  - Explosion of bottles
  - Crystals
  - Cloudiness (non bacterial)
  - Cloudiness (bacterial)
- What's that smell?
  - Vinegar odor
  - Geranium odor
  - Musty odor
  - Sulfur odor
  - Yeast flavor

# References


- appendix B in V9
- chapter 5 of B1
- Recht inV4 (chapter 13)
- Chapter 10 in V3
- chapters 15 and 16 from V3


June 11th 2002

# Stuck fermentation



### What?

- The specific gravity is still much higher than 1 -- the fermentation is not supposed to be done -- and nothing is happening. Or the fermentation does not start.

### Why?

- Too low or too high a temperature.
- Lack of nutrients.
- Excess of sugar.
- Excess of sulphite.
- Unhealthy yeasts.
- It can also happen that the fermentation is actually done: calculate the alcohol content and compare to the level the yeast is supposed to reach.

### What to do?

- If the problem comes from the fermentation temperature, move the must to a location thermally more adequate and wait until the fermentation spontaneously restarts. If the temperature was too

high, yeasts may be dead and the must has to be repitched. If it was too low, yeasts are "hibernating" but are not irreversibly harmed.
- If it is caused by a lack of nutrients, add some. If the fermentation does not (re)start, there must be another cause.
- To repitch: Prepare a new starter and pour it in the must after solving the initial problem (if the temperature is too high, the new yeasts will die as the other ones did).

### How to prevent?

- First of all, one must know the yeasts. Go to the web site of the maker or obtain a catalogue or a booklet showing the yeasts and their specifications. White wine yeasts are supposed to ferment between 15 and 20°C (60 to 70°F), red wine yeasts around 25°C (80°F). Some yeasts are "rustic" (bayanus for example) and they can tolerate unfavorable conditions (lack of nutrients, high alcohol content), but some others absolutely need nutrients. It must also be kept in mind that not all honeys provide the same amount of nutrients, so if one uses a different honey, it can be necessary to modify the amount of nutrient to be added.
- Generally speaking, yeasts do not like too much sugar in their environment (osmotic pressure). But a high alcohol content requires a lot of sugar, so it can sometimes be necessary to add a lot of honey. In this case honey should not be all added at once, several additions can lead to the same high alcohol content but at no time will the sugar content be too high. This prevents the Crabtree effect: when there is too much sugar, yeasts skip the respiratory phase and directly go to fermentation whereas they are still weak. Is there such a risk when a starter is used? No there should not be such a problem (as long as the specific gravity in the starter is not too high). But the osmotic pressure remains.

May 28th 2002

# My mead looks funny



## Oxidation

### What?

- Bitterness, browning of white wine (symptoms in mead should be of the same kind.)

### Why?

- Reaction with the oxygen of the air.

### What to do?

- No solution [V3].
- Add sulphite and vitamin C (anti-oxidants) [V4].
- Use casein to treat the color problem.

### How to prevent?

- Keep contacts with air to a minimum (little air space in carboys and bottles, no splashing of the

must when racking, avoid porous corks).
- Use antioxidants (sulfite and vitamin C).
- Maintain a low pH [V3].
- Maintain a low enough temperature [B2, V3].

# Explosion of bottles

### Why?

- Fermentation inside the bottles because the mead has been bottled before the fermentation was done or fermentation restarted inside the bottles.

### What to do?

- Uncork all bottles from the same batch and pour the content into a carboy with an airlock.
- If the mead is sparkling on purpose, use bottles suitable for the pressure of sparkling meads (Champagne bottles).

### How to prevent?

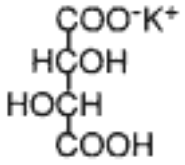
- Wait until the fermentation is done before bottling.
- Concerning sweet meads, prevent the fermentation from restarting using SO2 and sorbic acid (see Chemicals.)

# Crystals

### What?

- White crystals drop to the bottom of the fermentation vessel when it is kept at a low temperature.

### Why?




← *potassium bitartarate*

- Tartaric acid reacts with K+ ions (potassium ions) and forms potassium bitartarate (cream of tartar, left figure) that is not much soluble in the water-ethanol mixture at low temperature.

### What to do?

- Rack, dealing with crystals as if they were lees.
- Let the temperature go back up and the crystals will vanish (this phenomenon is fully reversible).
- Nothing: the crystals will stay at the bottom of the bottle and will not bother anybody.

### How to prevent?

- Do not use tartaric acid.
- Make this phenomenon happen: purposefully cool down the must then rack. The problem will not happen again when a bottle is put in the fridge. This is what winemakers call "cold stabilization".

## Cloudiness (non bacterial)

### What?

- Mead is not clear at all or there are particles in suspension. Flavor and nose are not abnormal.

### Why?

- There are yeast cells or proteins in suspension in the mead.

### What to do?

- Wait and rack. This will all flocculate naturally. If symptoms remain, add fining agents and rack.

### How to avoid?

- This is a natural phenomenon, it can be attenuated though if proteins are removed when honey is sanitized.

## Cloudiness (bacterial)

### What?

- The mead is not clear or particles can be seen. Furthermore, odor and/or flavor has an anomaly.

### Why?

- bacteria.

### What to do?

- First, how bad is it hurt? Some bacteria do not do much harm: it's possible that the mead still taste good and be safe.

### How to avoid?

- Keep contact with air to a minimum (to avoid introducing bacteria and providing it with the oxygen it needs).

- Reach an alcohol content of at least 12-14 % (24-28 proof). Concerning sherry (whose fermentation is partly aerobic), reach an alcohol content of 14-15 % (28-30 proof) before aerating to form the flor [V6].
- Sulphite [V6].
- Bacteria usually do not like low pH.

May 28th 2002

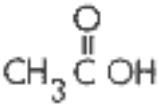
# My mead smells or tastes funny



## Vinegar odor

### What?

- The mead has a vinegar odor (acetic acid, figure). Sensory threshold: 175 ppm [B10].

*Acetic acid [B2]:* 

### Why?

- The acétobacter bacteria, naturally found in air, are responsible for the transformation of alcohol into acetic acid (acetic fermentation) according to the reaction [V6]:

$$C_2H_5OH + O_2 \rightarrow CH_4COOH + H_2O$$

ethanol + oxygen -> acetic acid + water

### What to do?

- Not much, except maybe find a book such as "What to do with 5 gallons of vinegar?"

- According to V3, it is possible to dissolve 2 tsp potassium bitartarate (cream of tartar) in 1 liter (1 qt) of the infected mead then add to the rest of the batch. If the flavor is not back to normal after a week or so, try again. After five unsuccessful attempts, bottle your vinegar. This treatment is at a short term and the mead will have to be drunk quickly.
- If damages are limited and if mead has no other flaw, V6 says it can be used for blending. J. Recht in V4 does not advise to do this and considers that the mead is lost.
- If a mead gets infected in a barrel (or any other vessel made of wood), the vessel is infected and hence can no longer be used.

### How to prevent?

- Keep contact with air to a minimum (to avoid introducing bacteria and providing it with the oxygen it needs).
- Reach an alcohol content of at least 12-14 % (24-28 proof). Concerning sherry (whose fermentation is partly aerobic), reach an alcohol content of 14-15 % (28-30 proof) before aerating to form the flor [V6].
- Sulphite [V6].
- A pH lower than 3.2 prevents acetic fermentation [V6] (it is not clear whether 3.2 is the limit or 3.2 works but a slightly higher pH can be OK too).

## Geranium odor

### Why?

- Transformation of sorbic acid by lactic bacteria [V4, V6].

### What to do?

- No solution [V3].

### How to prevent?

- Keep sorbic acid doses to a minimum and prevent bacteria from entering the must/mead (see vinegar odor above).

## Musty odor

### Why?

- Fungi or molds on the cork [V3].

### What to do?

- Immediately check other bottles. Concerning troublesome bottles, clean the inside of the neck

with a clean cloth soaked in a sulphite solution. Re-cork using new corks [V3].
- Check that the cellar is not too humid. If it is, decrease the humidity (humidity absorbers that can be purchased anywhere should do the job).

### How to prevent?

- Corks can be naturally porous but those split or with holes must not be used [V3].
- Keep the humidity of the cellar at a medium level.

## Sulfur odor

### Why?

- Excess of $SO_2$.

### What to do?

- Decant for a few hours [V4].

### How to prevent?

- Dose sulphite properly.
- Keep a low enough pH so that the amount of sulphite needed is fairly low.
- Use vitamin C along with $SO_2$ to reduce doses.

## Yeast flavor

### Why?

- There are yeast cells remaining in the mead.

### What to do?

- Age and rack from time to time.

### How to prevent?

- This is a natural phenomenon, there is not point trying to prevent it.

May 28th 2002

# Honey





Honey, as the main ingredient in mead, deserves a section of its own.

- Varietal honey
- History of bees, honey and beekeeping (this page is in the 'history' section.)
- Production: How much honey is produced and consumed in the world
- Cooking: Recipes using mead and honey
- Pollen, propolis, royal jelly and wax
- Composition of various varietal honeys (pdf)

## References


- beekeeping.com
- Honey.com
- Beehoo
- White JW: The hive and the honey bee... (1954)
- White JW et al.: Composition of American honeys, *USDA technical bulletin* **1261**, 1-124 (1962) 20 p about composition of honey, including tables of composition for each kind of flower.
- White JW: Honey, *Adv. Food res.* **24**, 287-374 (1978)
- Crane E.: Honey, a comprehensive survey, Heinemann (1979)
- Gayre G. R. : Wassail ! In mazers of mead, Brewers publications (1986) Très complet.

March 18th 2003

# varietal honeys



Varietal honeys
History history
Production
Cooking
Pollen, etc.
Composition pdf

All authors dealing with wines agree about it: grape is the single most important thing in wine making. Trying to imitate a great wine with poor grapes will result in a poor wine.

Maybe thousands of honeys exist worldwide for thousands of flowers exist. There are more than 300 types of honey available in the United States. Some can be found only in limited areas, others can be found more or less everywhere.

The most common honey, wild flowers honey, is characterized by... its lack of characterization, it is made from miscellaneous flowers. It can be light or dark, mellow to rather strong depending on flower species it contains. Some other honeys (heather, tulip poplar, buckwheat) are strong flavored. The issue is: are these flavors the ones one seeks in mead. It is therefore safer to start with rather neutral honeys like clover honey (if wild flower honey is used, the same honey is to be used each time as there are large differences between two different wild flower honeys).

Prices and chemical properties of honeys vary as much as their flavors. The flavor of lighter-colored honeys is generally milder, and the flavor of darker honeys stronger. On average, honey contains 17.2 % of water and 79.6 % of sugar (96 % of the dry mass). The main two sugars are fructose (38.2 %) and glucose (31.3 %). The quantities of water and sucrose (1.3 %) have an effect on crystallization. Maltose (7.3 %) and complex sugars (1.5 %) proportions have an effect on the complexity of the taste of honey. pH (3.9 on average!) is important for preservation and nitrogen (0.04 %) will help during fermentation (nutrients for yeasts). There are also 0.17 % ashes (minerals). The main acid of honey is gluconic acid [M2]. See composition.pdf to get the composition of lots of honeys.

When honey crystallizes, as crystals contain little water, the honey which remained liquid becomes richer in water; which can allow bacteria to develop.

Given the quantities to be used, buying honey in bulk may happen to be necessary to cut costs. It is better to buy little/not filtered/heated honey.

# Floral varietals

## Alfalfa

| | |
|---|---|
| Blooming period | summer |
| Color | White to extra light amber |
| Taste | fine flavor with a good body |

## Basswood

| | |
|---|---|
| Blooming period | late June and July |
| Color | water-white |
| Taste | It has a distinctive biting/sharp flavor. |

## Clover

| | |
|---|---|
| Blooming period | |
| Color | water-white to extra light amber |
| Taste | The most common floral source in the U.S. Clover honey has a mild, delicate flavor |

## Orange Blossom

| | |
|---|---|
| Blooming period | March and April |
| Color | white to extra light amber |
| Taste | This honey is often a combination of citrus floral sources. It has a distinctive flavor and the aroma of orange blossoms. |

## Sage

| | |
|---|---|
| Blooming period | |
| Color | white or water-white |
| Taste | mild, delicate flavor |

### Sourwood

| | |
|---|---|
| Blooming period | |
| Color | light |
| Taste | Specialty honey from North Carolina. Less sweet than most. |

### Tulip Poplar

| | |
|---|---|
| Blooming period | May |
| Color | dark amber |
| Taste | Its flavor is not as strong as could be expected from its dark color. |

### Tupelo

| | |
|---|---|
| Blooming period | April and May |
| Color | white or extra light amber with a greenish cast. |
| Taste | Tupelo honey has a mild, pleasant flavor. It is also known to be slow to crystallise and fairly expensive. |

### Wild flower

A blend of honeys. No two wild flower honeys have the same composition, so its color and taste vary greatly.

## References


honey.com

January 22nd 2003

# History of bees and honey



Flowers appeared on Earth 100 to 150 million years ago. Solitary bees appeared 25 millions ago and they became social insects about 10 to 20 millions years ago. Of course, man was not there yet at that time.

*Apis mellifera* (literally 'bee bringing honey') is the honey bee we know. Its name shows that at first men thought that bees carried honey from the flowers to the hive. It was only later that men understood that bees actually made honey. Of course bees do not make honey only for us to make mead, honey is used as food by the bees.

At first men got the honey from hives in rocks or hollow trees, only later did they bring the hives to them. The problem is: if bees are "wild" animals, who owns the honey? In the XIV$^{th}$ and XV$^{th}$ centuries, *bigres* in France and *Zeidler* in Germany were in charge of honey bees.

> "Avons droit d'avoir et tenir en la dite forest un bigre lequel peut prendre des mouches, miel et cire pour le luminaire de notre eglise, marquer, couper et abattre les arbres où elles seront sans aucun danger de reprise."

This text stating the rights of a lord means

> "We have the right to have in the said forest a *bigre* who can take bees, honey and wax for the lighting of our church, mark, cut and cut down trees where they [the bees] are not at risk of being caught [if the swarm cannot be caught without cutting down the tree, then...]"

Trees holding swarms were cut down and brought close to houses where the bees could be looked after

and where honey was easier to get. This is the basis of beekeeping. Earlier on, 4 500 years ago, Egyptians already kept bees in artificial shelters (rough hives.) Touthmonis III made bee the symbol of Low-Egypt. Many dynasty up to the Ptolemies, use the same hierogph for the bee and the pharaon.

## References


-  Vannier P.: Au pays du miel, Flammarion (1998)
- Levi-Strauss C.: From honey to ashes (1966)
- Gayre G. R. : Wassail ! In mazers of mead, Brewers publications (1986) (published with [H1] in a single book). Very complete.


January 25 th 2003

# honey production and consumption





## Production

| Continent | Prod. 1991 (1 000 tons) | Prod. 1997 (1 000 tons) | Prod. 2001 (1 000 tons) |
|---|---|---|---|
| Africa | 109 | 140 | 145 |
| America (North & central) | 222 | 189 | 205 |
| U.S.A. alone | | 89 | 100 |
| South America | 87 | 109 | 131 |
| Argentina alone | | 75 | 90 |
| Asia | 334 | 402 | 465 |
| China alone | | 215 | 256 |
| ex-USRR alone | | 136 | 125 |
| Europe | 180 | 281 | 288 |
| E.U. alone | | 106 | 111 |
| Oceania | 29 | 36 | 29 |
| **Total** | 961 | 1156 | 1263 |

# Exportations

| Country | 1991 (1 000 tons) | 2000 (1 000 tons) |
|---|---|---|
| China | 70 | 103 |
| Argentina | 47 | 88 |
| Mexico | 50 | 31 |
| U.E. | 26 | 48 |
| **Total** | 280 | 375 |

# Importations

| Country | 1993 (1 000 tons) | 2000 (1 000 tons) |
|---|---|---|
| U.S.A. | 61 | 90 |
| Japan | 36 | 40 |
| E.U. | 146 | 193 |
| **Total** | 275 | 370 |

# Hives in Europe

| Country | number of hives - total (1992) | number of hives - total (2002) | number of hives - professionals (1992) | number of hives - professionals (2002) |
|---|---|---|---|---|
| Spain | 1 854 000 | 2 314 500 | 1 242 400 | 1 681 000 |
| France | 1 434 000 | 1 297 000 | 528 000 | 528 000 |
| Greece | 1 225 000 | 1 380 000 | 770 000 | 770 000 |
| Germany | 1 010 000 | 900 000 | 80 000 | 50 000 |
| Italy | 1 000 000 | 1 100 000 | 300 000 | 300 000 |
| Portugal | 510 000 | 632 500 | 177 000 | 345 000 |
| Austria | ? | 343 000 | ? | 30 000 |
| U.K. | 200 000 | 273 500 | 40 000 | 40 000 |
| **Total** | 7 540 000 | 8 793 000 | 3 163 000 | 3 793 000 |

# Beekeepers in Europe

| Country | total beekeepers (1992) | total beekeepers (2002) | professional beekeepers (1992) | professional beekeepers (2002) |
|---|---|---|---|---|
| Spain | 20 150 | 26 670 | 4 550 | 4 000 |

| | | | | |
|---|---|---|---|---|
| France | 1000 000 | 100 000 | 3 000 | 3 000 |
| Greece | 23 000 | 22 000 | 3 000 | 4 000 |
| Germany | 94 000 | 103 600 | 400 | 300 |
| Italy | 80 000 | 75 000 | 1 000 | 1 100 |
| Portugal | 50 000 | 26 000 | 1 000 | 1 800 |
| Austria | ? | 25 000 | ? | 150 |
| U.K. | 35 000 | 43 600 | 200 | 200 |
| **Total** | 435 000 | 470 000 | 13 350 | 14 800 |

## References


- beekeeping.com


March 12th 2003

# mead, honey, cooking

Map
Contact
Links
Mead tasting History Mead making Honey Science Society Quiz Glossary L'hyd
Varietal honeys
History history
Production
Cooking
Pollen, etc.
Composition pdf

Recipes have been selected but they are still to be typed in.

March 12th 2003

# Other bee products
# pollen, propolis, royal jelly, wax



This page is about products other than honey: pollen, propolis, royal jelly, wax.

## Pollen

Pollen is the male part of the flower. It is a dust which generally is yellowish but may be red or purple. Bees, as they (unwillingly) drop pollen on the pistil (female part) of flowers, account for 80 % of pollination.

Pollen is made of 15-18 % of water, 35 % of carbohydrates, 20 % of proteins as well as vitamins, minerals, amino acids which are lacking in honey:

- vitamin A (retinol)
- vitamin B1 (thiamine)
- vitamin B2 (riboflavin)
- vitamin B3/PP (nicotinamide)
- vitamin B5 (pantothenic acid)
- vitamin B6 (pyridoxine)
- vitamin C (ascorbic acid)
- vitamin E (tocopherol)

## Propolis

The word "propolis" comes from the Greek: "*pro*" means "before" and "*polis*" means "city". The word may have been created by Aristotle (-384 - -322.)

Propolis is a resin-like paste which is gathered by the bees from the buds and the bark from some trees. They bring it back to the hive in their pollen baskets and mix it with wax. They use it in the hive as mastic to reduce the size of an entrance for instance. Its antiseptic properties enable a safe environment as walls are covered with it. It is also used to embalm predators that tried to steal honey. Raw propolis contains 40 % of impurities (wax, vegetal fibers, pollen, dead bees, sand, etc.)

## Royal jelly

It is a white to light yellow substance highly acidic secreted by the young nurse bees. In the hive, these nurse bees produce the royal jelly and feed young larvae with it for 2 or 3 days. Queens on the other hand are fed on royal jelly during their whole life. Thus it is only in royal cells (those of queen larvae) that royal jelly is found in quantity large enough to be extracted.

A queen egg is identical to a worker egg; in spite of this, she is twice as long and lives for up to 4 or 5 years (workers generally do not live over a month.) The queen is capable of laying up to three thousands egg per day during the season. It can therefore be said that royal jelly is directly accountable for the longevity and extraordinary capabilities of the queen. Royal jelly contains 60-70 % of water, lipids (18 %, mostly fatty acids), carbohydrates (11 %), proteins (2 %), vitamins, hormones, enzymes, minerals and compounds yet to be identified (3 % of the total.)

## Wax

It is produced by the workers, the only bees with the right glands under their abdomen. Wax is used as a structure material to make cells. It takes 2 kg of sugar to 1 kg of bees (a dozen thousands insects) to make 50 g of honey. It is therefore not surprising that beekeepers provide premade cells to reduce the energetic expense of the bees and enable them to keep focused on making honey. Wax composition is stable: it weakly depends on the area or the bee species.

## References


- Draper's honey
- Fr Vannier P. : Au pays du miel, Flammarion (1998)


March 18th 2003

| | color | water (%) | sugar (%) glucose (dextrose) | fructose (levulose) | sucrose (G - F) | maltose (G - G) | complex | *maltose + complex* | *total sugar* | | pH | total acids (meq/L) | ashes (%) | nitrogen (%) | States where this honey is produced | commentaires |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mean | | 17.2 | 31.3 | 38.2 | 1.3 | 7.3 | 1.5 | *8.8* | *79.6* | *96.1* | 3.90 | 29.12 | 0.169 | 0.041 | | |
| Std deviation | | 1.5 | 3.0 | 2.1 | 1.0 | 2.1 | 1.0 | *3.0* | *1.0* | *1.0* | 1.00 | 10.33 | 0.150 | 0.026 | | |
| alfalfa | | 16.2 | 33.4 | 39.1 | 2.6 | 6.0 | 0.9 | *6.9* | *82.1* | *97.9* | 3.81 | 27.01 | 0.093 | 0.033 | | [3] : delicate |
| aster | | 17.4 | 31.3 | 37.6 | 0.8 | 8.5 | 1.0 | *9.5* | *79.2* | *95.9* | 4.68 | 22.39 | 0.302 | 0.043 | KY, MS, PA | |
| bamboo (japanese) | | 19.1 | 29.3 | 35.6 | 0.7 | 9.8 | 2.0 | *11.8* | *77.3* | *95.5* | 4.08 | 25.09 | 0.142 | 0.054 | FL | |
| basswood | | 17.4 | 31.6 | 37.9 | 1.2 | 6.9 | 1.4 | *8.3* | *79.0* | *95.6* | 4.05 | 23.70 | 0.840 | 0.022 | MD, Ws, IO | [3] : complex and interesting, woody (?) |
| blackberry | | 16.4 | 25.9 | 37.6 | 1.3 | 11.3 | 2.5 | *13.8* | *78.7* | *94.1* | 4.50 | 29.40 | 0.399 | 0.055 | GA, MD | [3] : fruity |
| blueberry | | 17.4 | 31.6 | 37.2 | 0.8 | 9.1 | 0.9 | *10.0* | *79.5* | *96.3* | 4.36 | 21.29 | 0.163 | 0.059 | MI, Maine | [3] : blueberry flavor: weak to non-existent |
| bluevine | 4 | 16.1 | 28.3 | 35.4 | 2.6 | 7.2 | 5.3 | *12.5* | *78.8* | *93.9* | 3.90 | 22.83 | 0.103 | 0.040 | MO | |
| buckwheat | | 18.3 | 29.5 | 35.3 | 0.8 | 7.6 | 2.3 | *9.9* | *75.4* | *92.3* | 3.97 | 42.06 | 0.224 | 0.064 | PA, MD, Minn, OH | [3] : strongest and darkest |
| chinquapin | | 15.8 | 23.9 | 33.6 | 0.9 | 12.7 | 4.8 | *17.5* | *75.9* | *90.2* | 4.95 | 31.93 | 0.761 | 0.052 | FL, CA | |
| clover (sweet) | | 17.7 | 31.0 | 38.0 | 1.4 | 7.8 | 1.4 | *9.2* | *79.5* | *96.6* | 3.77 | 26.53 | 0.071 | 0.039 | | |
| clover (white) | 5 | 17.9 | 30.4 | 38.2 | 1.1 | 7.4 | 1.7 | *9.1* | *78.7* | *95.9* | 3.88 | 31.83 | 0.178 | 0.047 | | [1] : great case honey for flavored meads |
| coralvine | 11 | 16.8 | 28.5 | 34.9 | 0.6 | 6.1 | 3.0 | *9.1* | *73.1* | *87.8* | 4.32 | 55.11 | 0.592 | 0.057 | TX | |
| cotton | | 16.1 | 36.7 | 39.3 | 1.1 | 4.9 | 0.5 | *5.4* | *82.5* | *98.4* | 4.29 | 29.82 | 0.339 | 0.037 | | [3] : sweet |
| cranberry | 9 | 17.2 | 28.1 | 35.6 | 1.0 | 8.0 | 3.0 | *11.0* | *75.7* | *91.4* | 4.37 | 30.14 | 0.330 | 0.041 | MS | [3] : exciting |
| eucalyptus | | 17.0 | 32.3 | 39.4 | 1.4 | 6.8 | 0.8 | *7.6* | *80.7* | *97.2* | 4.14 | 26.46 | 0.204 | 0.050 | | [3] : eucalyptus flavor: present to hardly noticeable |
| fireweed | | 16.0 | 30.7 | 39.8 | 1.3 | 7.1 | 2.1 | *9.2* | *81.0* | *96.4* | 3.03 | 26.77 | 0.108 | 0.032 | | [1] : not much taste ; NO -- [3] : butter like taste |
| fox glove | | | | | | | | | *0.0* | | | | | | | [3] : complex, hard to describe |
| gallberry | | 17.1 | 30.2 | 39.9 | 0.7 | 7.7 | 1.2 | *8.9* | *79.7* | *96.1* | 4.20 | 20.65 | 0.163 | 0.028 | | |
| goldenrod | | 17.0 | 33.2 | 39.6 | 0.5 | 6.6 | 0.6 | *7.2* | *80.4* | *96.9* | 4.45 | 22.05 | 0.263 | 0.045 | | |
| heather | | | | | | | | | *0.0* | | | | | | | [3] : one of the strongest (not everybody likes it) |
| holly | | 17.5 | 26.7 | 39.0 | 1.0 | 10.1 | 2.2 | *12.3* | *78.9* | *95.6* | 4.16 | 29.61 | 0.174 | 0.041 | | [3] : very pleasing, nutty aftertaste |
| honeydew (cedar) | 11 | 13.7 | 25.6 | 25.1 | 0.8 | 6.0 | 10.1 | *16.1* | *67.6* | *78.3* | 4.54 | 66.28 | 1.072 | 0.048 | CA | |
| honeydew (hickory) | 10 | 15.3 | 23.9 | 31.1 | 1.0 | 9.0 | 7.8 | *16.7* | *72.8* | *85.9* | 4.70 | 37.75 | 0.670 | 0.050 | CT | |
| honeydew (oak) | 10 | 16.9 | 27.4 | 34.8 | 0.8 | 10.5 | 2.2 | *12.6* | *75.7* | *91.1* | 4.35 | 57.05 | 0.579 | 0.127 | CA, FL, OR | |
| laurel (mountain) | 1 | 15.6 | 24.2 | 35.3 | 0.5 | 17.6 | 2.5 | *20.1* | *80.2* | *95.0* | 4.49 | 12.58 | 0.219 | 0.029 | TN | |
| locust (black) | | 17.3 | 28.0 | 40.7 | 1.0 | 8.4 | 1.9 | *10.3* | *80.0* | *96.7* | 4.03 | 15.54 | 0.052 | 0.018 | IN, MD, OH | |
| mesquite | | 15.5 | 36.9 | 40.4 | 1.0 | 5.4 | 0.4 | *5.8* | *84.0* | *99.4* | 4.20 | 16.33 | 0.129 | 0.012 | | [1] : good candidate by the numbers -- [3] : light and delicate |
| mint | | 17.1 | 32.0 | 41.0 | 0.9 | 5.9 | 0.8 | *6.8* | *80.7* | *97.3* | 4.43 | 34.16 | 0.346 | 0.038 | | [3] : light and refreshing |
| mustard | 9 | 18.1 | 26.4 | 37.3 | 0.5 | 11.1 | 1.7 | *12.8* | *76.9* | *93.9* | 4.38 | 34.55 | 0.152 | 0.324 | MD | |
| oak (poison) | 5 | 16.0 | 28.2 | 37.9 | 0.7 | 10.2 | 2.8 | *13.0* | *79.7* | *94.8* | 4.53 | 23.32 | 0.284 | 0.051 | OR | |
| orange (CA) | | 16.5 | 32.0 | 39.1 | 2.7 | 6.3 | 1.2 | *7.5* | *81.3* | *97.3* | 3.84 | 30.34 | 0.073 | 0.014 | CA, FL | [1] : excellent candidate; use extra yeat nutrients |
| palmetto | 6 | 17.4 | 29.5 | 38.2 | 0.8 | 9.6 | 1.6 | *11.1* | *79.6* | *96.3* | 4.51 | 15.71 | 0.262 | 0.019 | FL | [3] : rather strong, rich and sweet |
| peppervine | 10 | 17.8 | 25.3 | 36.2 | 1.0 | 13.5 | 1.9 | *15.4* | *77.9* | *94.8* | 3.92 | 32.33 | 0.148 | 0.017 | TX | |
| prune | | 19.4 | 28.1 | 36.9 | 0.4 | 10.5 | 0.8 | *11.2* | *76.7* | *95.1* | 6.10 | 11.80 | 0.694 | 0.095 | | |
| purple loosestrife | | 18.3 | 29.9 | 37.8 | 0.6 | 8.1 | 2.4 | *10.5* | *78.8* | *96.4* | 3.80 | 28.86 | 0.125 | 0.044 | MI, NY, NC | |
| raspberry | | 17.4 | 28.5 | 34.5 | 0.5 | 5.7 | 3.6 | *9.3* | *72.8* | *88.1* | 4.04 | 39.19 | 0.471 | 0.070 | NY, PA | [1] : very hi sugar blend => complexity; hi N benefits fermentation -- [3] : slightly fruity |
| rhododendron | 0 | 16.1 | 26.5 | 33.6 | 0.5 | 13.0 | 2.4 | *15.4* | *76.0* | *90.6* | 4.78 | 10.15 | 0.179 | 0.028 | NC | |
| sage | | 16.0 | 20.2 | 40.4 | 1.1 | 7.4 | 2.4 | *9.8* | *71.5* | *85.1* | 3.51 | 29.10 | 0.108 | 0.037 | CA | [1] : to be explored |
| snowbrush | 6 | 13.7 | 31.0 | 37.8 | 1.4 | 8.8 | 3.2 | *12.1* | *82.2* | *95.2* | 3.88 | 45.69 | 0.187 | 0.059 | CA | |
| sourwood | | 17.4 | 24.6 | 39.8 | 0.9 | 11.8 | 2.4 | *14.2* | *79.6* | *96.3* | 4.53 | 16.95 | 0.258 | 0.034 | NC, VA | [1] : very intersting candidate -- [3] : delicate, subtle |
| sumac | | 17.6 | 24.4 | 31.5 | 1.8 | 8.2 | 6.9 | *15.1* | *72.7* | *88.3* | 4.42 | 44.10 | 0.931 | 0.056 | CT, VA, MD | |
| thistle (star) | 4 | 15.9 | 31.1 | 36.9 | 2.3 | 6.9 | 2.7 | *9.7* | *80.0* | *95.1* | 3.54 | 41.65 | 0.097 | 0.055 | CA | [3] : "living" |
| thyme | | 16.8 | 31.2 | 37.1 | 0.9 | 8.8 | 1.7 | *10.5* | *79.7* | *95.8* | 4.80 | 27.88 | 0.384 | 0.057 | NY | |
| tulip poplar | | 17.6 | 25.9 | 34.6 | 0.7 | 11.6 | 3.0 | *14.6* | *75.8* | *92.0* | 4.45 | 42.99 | 0.460 | 0.076 | MD, TN, IN | [3] : 2nd (after buckwheat) strongest and darkest. Woody. Gives a dark intense mead |
| tupelo | | 18.2 | 26.0 | 43.3 | 1.2 | 8.0 | 1.1 | *9.1* | *79.6* | *97.3* | 3.87 | 36.59 | 0.128 | 0.046 | FL | [1] : attractive to brewers -- [3] : one of the sweetest |
| vetch (hairy) | | 16.3 | 30.6 | 38.2 | 2.0 | 7.8 | 2.1 | *9.9* | *80.8* | *96.5* | 3.73 | 23.02 | 0.056 | 0.030 | south west | |

[1] : McConnell [2] : Miller [3] : Castlemark honey

# Yeast





Yeasts used to make mead are close to the baker's yeast and biologists do not necessarily make a difference between these yeasts which, although very close from a biology standpoint, are used for different purposes. Yet baker's yeast is not used to make alcohol. Baker's yeast produces alcohol and $CO_2$ from starch contained in flour, Alcohol evaporates due to high baking temperature (higher than 400° F) and $CO_2$ will form bubble, giving some volume to the bread.

To make drinks, one focuses mainly on alcohol and let $CO_2$ go (except for the second fermentation of champagne). Although aims are different, the basic principle is the same.

Unlike grapes which have yeasts (on their surface), honey does not contain much yeast. A fermentation relying only on wild yeasts would require months to start and would not be reliable. F1 tells the story of « traditional method » rhubarb wine, that is without adding yeast. The wine had methanol (toxic) and acetaldehydes (15 times as powerful as ethanol to provoke drunkenness). The result could even be a coma even when the consumption was moderate. Therefore wine yeasts are generally added for more safety and control. Nitrogen-containing molecules are also added as well as vitamins for honey contains very little of them.

There are three important types of yeasts (from the point of view of their utilisation, not from the point of view of biologists' nomenclature): baker's yeast, beer yeast and wine yeast.

Some people (a minority) use beer yeast to make mead. They are of two kinds: ale (saccharomyces cerevisiae) and lager (saccharomyces uvarum).

Most wine yeasts are also saccharomyces cerevisiae (Champagne yeasts are saccharomyces bayanus). One distinguishes between white wine yeast and red wine yeast (and a few specialized yeast as Sherry yeast).

These yeasts come in two forms. 5 g packages of dry yeast (cheap) are sold by Lalvin (lallemandwine.com) and by Red star (redstaryeast.net/). White labs (whitelabs.com) and Wyeast (wyeastlab.com) sell their yeasts in liquid form (much more expensive but supposed to be purer). White labs commercializes a yeast dedicated to mead and Wyeast has two of them (dry and sweet) but there are not well distributed and so there are harder to find than usual wine yeasts.

Yeasts will give different flavors but they will also lead to different alcohol contents and different quantities of residual sugar. Some yeasts (not very numerous) will not ferment beyond 4 % of alcohol, others (bayanus for example) can reach around 35 proof. Some have a low attenuation (proportion of sugar transformed into alcohol): they leave a lot of sugar and the result is sweeter than with other yeasts. On the other hand, some yeasts (bayanus again -- Champagne yeasts) will lead to a dry mead, really dry. One has to take this into account when a yeast and a quantity of honey are to be chosen.

Anyway, after the half dozen years of recommended ageing, the difference between different yeasts will have died out [V2].

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# Embedded Secure Document

The file *http://www.meadmadecomplicated.org/mead_making/ingredients/commercial_yeast.pdf* is a secure document that has been embedded in this document. Double click the pushpin to view.

# Water



Bernstein and Willox in "the practical brewer" stress the importance of the choice of water in brewing beer. It is well known among beer brewers that some types of beer require precise kinds of water. But there is not such a thing as a famous mead and its associated water. Other criteria will have to be found.

The cheapest water is tap water. Unless it is bad to the point that it cannot be drunk, it is more simple and less expensive to use the tap than to buy spring water (ask the city water department to get information). Boiling tap water for 10-15 min before using it is a good way of getting rid of some of the chlorine it contains (but it takes some time for the water to cool down and one has to keep in mind that more than a quart of water must be boiled to eventually get a quart). During fermentation, chlorine could be turned into chlorophenols which tastes like plastic [B1].

There are enough different honeys and yeasts not to try and use some awkward water. If one gets a good result with some honey-yeast combination using tap water, it is possible to use the same honey and the same yeast with various fancy spring waters.

According to H4, water must be chosen to match honey: a low minerals water and a honey with little ashes (mineral matter) may not provide the minerals yeasts need. On the other hand, a high minerals water will not fit a high ashes honey.

B1 gives a rather complete list of minerals found in water, including their effects on flavor and fermentation.

Demineralized water -- containing no minerals at all -- is to be avoided.

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