MEAD SUCCESS:

INGREDIENTS, PROCESSES AND TECHNIQUES

BY

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We love mead. It is the granddaddy of all fermented beverages, perhaps as old as the first dip of a hand into the fermented honey and rainwater in the crook of a tree. Yet here we are in the 1990s, going to tremendous lengths to buy the finest Belgian malts, the freshest imported hops and most obscure yeast strains for brewing beer, but brew our meads with supermarket honey of undetermined origin and unspecified, probably unspeakable, age.

The time has come to push meadmaking into the same analytic and scientific realm that beer brewers have applied to their craft for quite some time. We believe that by understanding honey, water and yeast in the same way we understand yeast, malt, water and hops, we can elevate mead to the same level of quality and public acceptance that high-quality beers enjoy.

Honey is a remarkable liquid. In addition to a rather complex mixture of sugars, honey contains many enzymes, proteins, organic compounds and trace minerals (White 1975). These interesting compounds, present in minute quantities, give honey its distinctive flavors and characteristic aromas. Many of these flavors and aromas lend a recognizable distinction to the finished mead. In producing a high-quality, complex beverage from honey, it is our aim to preserve as much of these distinctive flavors and aromas as is possible.

The subtle nature of honey allows a great deal of latitude in additives designed to enhance the character and complexity of mead. We have experimented with a large number of fruits, vegetables, herbs and spices added to basic mead with both overt and subtle results. The addition of various ingredients produces meads fitting into specific subcategories of the style. Show mead is defined as a beverage produced by the fermentation of honey alone. Nutrients and additives are allowed, but no additional spices, fruits or herbs. In traditional mead, small amounts of fruits, spices and herbs are allowed, but they must never overpower the honey flavor and aroma. These additives are to play a supportive role at or below the flavor threshold. Pyments, cysers and melomels are meads that include the addition of grapes, apples and other fruits, respectively. Metheglin is a mead to which spices have been added. Hippocras refers to a spiced pyment, and braggot is a beverage made from honey and malt sugars. Clearly there can be many subclasses of these categories, and therein lies the never-ending challenge of brewing mead.

The history of honey and meadmaking is long and rich, but unfortunately outside the scope of this article. *Brewing Mead, Wassail! In Mazers of Mead* (Brewers Publications, 1986) and *Making Mead* (Argus Books, 1984) are highly recommended books.

HONEY

We recommend the use of fresh honey that has undergone the least amount of processing possible. Commercially blended honey (commonly listed as clover or

Making Your First Me

FIRST, PURCHASE OUTSTANDING HONEY. Single-source (varietal) honey a wonderful character and complexity to mead. Any local orchard can provide th name of their pollinator who can unlock a treasure trove of honey suppliers. A local farmers market also can be a good source of varietal honey. Specialty or organic food co-ops are good possibilities. Unique honey makes for unique mead, and freshness is of utmost importance. We've used orange blossom honey here because it is widely available and know it makes a very good mead, but substitute any high-quality honey you can find in your area.

DRY SPARKLING MEAD

Ingredients for 5 gal (19 L)

10 lb orange blossom honey (4.5 kg)
2 tsp yeast energizer (9.9 mL)
2 tsp yeast nutrient (9.9 mL)
yeast starter culture

3/4 cup dextrose (113 g) and
3 tsp acid blend dissolved in boiling water (14.8 mL) (added at bottling)

fresh yeast culture

MEDIUM-SWEET STILL MEAD

Ingredients for 5 gal (19 L)

12 1/2 to 15 lb orange blossom honey (5.67 to 6.8 kg)
2 tsp yeast energizer (9.9 mL)
2 tsp yeast nutrient (9.9 mL)
yeast starter culture

4 tsp acid blend dissolved in boiling water (19.7 mL) (added at bottling)

Bring 4 gallons (15 liters) of water, yeast energizer and yeast nutrient to a boil with your immersion chiller in place. Add the honey, stirring well (crystallized honey may be liquefied by placing the honey in a pot of hot water). The temperature will drop to a suitable pasteurization temperature for the honey must. Allow this mixture to stand 10 minutes, then chill to 70 degrees F (21 degrees C). When cool, siphon to a sanitized carboy and pitch the yeast culture.

Allow to ferment at about 70 degrees F (21 degrees C) until fermentation has slowed considerably (four to six weeks). Rack to a secondary fermenter and let stand until clear. (Finings may be added at this point to assist clarification, but we prefer to let the mead clarify naturally.) Natural clearing may take six to 12 months. Additional racking may expedite the process.

Final gravity is tremendously dependent not only on original gravity, but honey variety as well. A better indicator of complete fermentation is the absence of air lock activity and visual clarity of the mead. When you are satisfied that fermentation is complete, the mead may be bottled as a still mead or carbonated by adding one-half cup (118 mL) of honey or three-fourths cup (113 grams) of dextrose in 12 ounces (355 milliliters) of boiling water. It is important to include a fresh dose of yeast at bottling to ensure adequate carbonation.

wildflower) may be consistent, a good base honey for fruit meads, and offers repeatable results, but it is our contention that far more interest, variety and complexity can be achieved through the use of a pure varietal honey source. The USDA describes varietal honey as having a single blossom as its primary source, such as orange blossom, fireweed or tupelo. These honeys can then be blended by the meadmaker to adjust deficiencies, dilute unwanted constituents or add an amazing array of pleasing aroma and flavor combinations.

Honey that has been minimally processed by gentle heating (140 degrees F or 60 degrees C) typically will tend to crystallize in two to four months. This is not a problem for quality and using crystallized honey will not ruin the resulting mead. Honey is best stored at freezer temperatures to reduce enzymatic action and prevent degradation and color changes.

NUTRIENTS

Yeast requires nitrogen in the respiratory phase of growth. Because honey is a poor source of nitrogen, mead fermentations without adequate nutrition are notoriously slow. The addition of yeast nutrients (diammonium phosphate), yeast energizer or Fermaid™ (diammonium phosphate, magnesium sulfate, yeast, folic acid, niacin, sodium pantothenate and thiamin), yeast hulls or yeast extract is very important to promote complete and rapid fermentation. These materials are readily available and their use is encouraged. We have been using both yeast nutrients and yeast energizer at two-fifths tablespoons per gallon (1.1 mL per liter) or two tablespoons (29.6 mL) in a five-gallon (19-liter) batch.

ACID

The use of acids such as citric, malic, tartaric, acid blend or lemon juice has been widely recommended to balance any residual sweetness in the finished mead. Some sweet-acid balance is desirable but optional. Furthermore, the addition of acids before fermentation can reduce the pH of the honey must, resulting in a more sluggish fermentation. The pH of honey already is low (averaging 3.9), and because honey has very little buffering capacity, the pH drops to a range that slows yeast activity when fermentation commences. In our experience, adding acid after fermentation to a finished mead is a more reliable method to achieve the desired sweet-sour balance without compromising the health of the yeast.

TECHNIQUES

Among the more controversial topics in mead production is the treatment of honey must prior to fermentation. Treatments include boiling, sulfiting, pasteurization, sterile filtering and no treatment whatsoever. Many excellent texts provide step-by-step methods to produce high-quality meads (Morse 1980, Gayre 1986).

The method of sanitation most commonly advocated is boiling the must. While this technique does possess some distinct advantages as far as coagulation and subsequent protein removal are concerned, resulting in a more rapid clarification, the disadvantage is the loss of valuable aroma components driven off in the boil. A technique in which the must is briefly boiled, just long enough for the coagulated protein to be removed (boiling until the coagulated protein no longer forms at the surface) then rapidly chilled, offers a good compromise. This method is simple and straightforward; and we recommend a 15-minute boil to beginning meadmakers.

The use of sodium metabisulfite, or Campden tablets, offers the distinct advantages of no heating and thus no aroma losses caused by volatilization. This method is the fastest becaus simply mixed with water and t st is pitched the following day. tages are that some people a these compounds and proper adj the addition requires both an accura and pH meter. Also, sulfites tend to ble fruit. Another disadvantage is that the proteins are not removed and the meads may require postfermentation fining to clarify.

When added to honey must, sodium or potassium metabisulfite releases sulfur dioxide (SO_2), which is the active ingredient responsible for stunning wild yeasts and microorganisms. The pH of the must affects the amount of free SO_2 present and should therefore be taken into account. Table 1 shows the recommended levels of SO_2 to treat white wine and these values may be directly substituted in a mead. Although these values represent the optimal levels of sulfite required to release an appropriate dose of SO_2, the authors tend to err on the short side of the equation, adding at most one Campden tablet per gallon (3.79 liters). Each Campden tablet contains 0.016 ounces (0.44 grams) of sulfite which releases approximately 50 ppm of SO_2, so for those who have an accurate balance the weight in grams of sodium or potassium metabisulfite may be calculated from the table.

Pasteurization is the treatment method we recommend. It is safer, faster, requires less equipment than other methods and offers a compromise between sanitation and loss of aroma compounds. A disadvantage is that the proteins are not removed and meads prepared this way may require fining to clarify. For the experimental batches made in preparation for this article we brought the water to a boil and added the honey, allowing the temperature to settle at about 160

TABLE 1. pH Effect on Sulfite Additions (Cox 1985)

pH of must	Required ppm free SO_2	Sulfite grams per gallon	Campden tablets per gallon
3.0	40	0.29	2/3
3.2	60	0.59	1 1/3
3.4	70	0.66	1 1/2
3.6	80	0.73	1 2/3
3.8	120	1.10	2 1/2

degrees F (71 degrees C). In retrospect, this may have been somewhat higher than needed because data suggest that as little as 22 minutes at 140 degrees F (60 degrees C) is sufficient to kill wild yeast (White 1966).

For those who have the equipment, ultrafiltration with a 50 kilo Dalton (standard unit for measuring protein) molecular weight cutoff membrane has shown some promise (Kime 1991). This technique simultaneously provides both sterile filtering and protein removal. This process resulted in mead that required less aging and was free of harshness.

FERMENTATION

A major issue in meadmaking is the notoriously long fermentation period. Fermentation rate is dependent to some extent on the honey variety, but through proper selection of yeast strains, agitation during fermentation, yeast nutrition and control of pH, one can dramatically increase the fermentation rate. Therein lies another controversy: clearly, commercial operations are interested in rapid fermentations for economic reasons. The economics of capital tied up in fermenters is not as problematic for homebrewers. More significant is the effect on flavor. There are some who object to the flavor of mead that has had a long, slow fermentation on the yeast because of the taste associated with autolysis. Others find the taste familiar and similar to that of a fine sur lie Champagne in which the toasty-yeasty flavor of autolysis is a welcome and integral part of the taste profile. We prefer a more relaxed approach favoring long fermentations, although recently we have been experimenting with accelerated methods.

The single most significant factor affecting the rate of mead fermentation is yeast health. This may be ensured by providing adequate nutrients in the form of Yeast Energizer and yeast nutrients as well as careful monitoring of pH throughout fermentation. Most of the required nutrients are available in the commercial preparations, but additional nutrients such as biotin, pyridoxine and peptone may be helpful. Morse found that the most rapid fermentations were achieved when a balanced salt, buffer and nutrient additive was used (Morse 1975). Morse and Steinkraus report fermentations to 12 percent alcohol in less than two weeks by using one ounce per gallon (6.75 grams per liter) of Formula 1 and 0.03 ounces per gallon (0.25 grams per liter) of Formula 2 as shown on Table 2. It is important to note that most of these required ingredients can be found in commercially available yeast energizer.

The pH of honey is naturally low, and because it is poorly buffered the pH of must may drop during fermentation to a point at which the yeast is unable to ferment efficiently. The addition of a basic buffer helps greatly by holding the pH to between 3.7 and 4.0 throughout the course of fermentation. We have had success fermenting a mead to completion in two weeks simply by providing adequate nutrition (yeast energizer), saturating the cooled must with oxygen and adding calcium carbonate to hold the pH above 3.7. Other salts that may be used include potassium carbonate and potassium bicarbonate (Moorhead 1993). Care must be exercised because all of these salts can add a bitter-salty flavor if overused, so a minimum of these compounds is recommended. It is best to carefully monitor the pH on a daily basis with a pH meter (papers will not provide the needed accuracy) and add just enough $CaCO_3$ to raise the pH to the desired range.

TABLE 2. Nutrient Mixtures for Mead Fermentations

Formula 1	
ammonium sulfate	[illegible]
K_3PO_4	[illegible]
$MgCl_2$	[illegible]
$NaHSO_4$	[illegible]
citric acid	2.53 g
sodium citrate	2.47 g

Formula 2	
biotin	0.05 mg
pyridoxine	1.00 mg
mesoinositol	7.50 mg
calcium	10.00 mg
pantothenate thiamin	20.00 mg
peptone	100.00 mg
ammonium sulfate	861.45 mg

YEAST

A large variety of yeast is now available to the small-scale meadmaker. Some have been reviewed in *Stimulate Your Senses with Mead* in ***zymurgy*** Fall 1992 (Vol. 15, No. 3) (Price 1992). Most wine yeast strains will perform nicely, and indeed some are very good at fermenting low-nutrient musts. There are several commercial sources for high-quality mead yeasts and most are now available as pure cultures on slants, eliminating bacterial contamination sometimes encountered in the dry yeast packets. We have discovered, however, that bacterial contamination is a minor issue in mead fermentations. Of far greater consequence is the potential for postfermentation oxidation or contamination during processing or storage with acetobacter species that may result in the production of honey vinegar. Most of these problems can be prevented with good sanitation practices, avoiding aeration during transfer or preventing oxygen from reaching the mead by keeping carboys or barrels filled.

Because meads generally start out with high sugar content (around 20 percent) it is prudent to pitch a large volume of yeast. We recommend pitching the slurry from a prepared starter that is no less than 10 percent of the volume of the main fermentation. This starter may be prepared from a variety of fermentable sugars provided sufficient nutrition is available to the yeast. We recommend the use of yeast energizer to provide these nutrients because it contains vitamins and minerals in addition to a nitrogen source. Although expensive, an ideal supplement is Yeast Nitrogen Base produced by Difco. Allow the starter to ferment to completion, decant the top (spent) media and pitch the slurry to avoid diluting the honey must.

As in all of your brewing, quality ingredients are worth the extra effort and expense; good honey makes good mead. Low nutrient levels in honey may cause unnecessarily long and slow fermentation, therefore add plenty of yeast nutrients. Poorly buffered honey may result in the pH falling to unacceptable levels during fermentation, therefore the addition of $CaCO_3$ may prevent this pH decrease and accelerate the fermentation.

Mead is easy to make and the effort will produce a beverage of incredible complexity and a source of pleasure for many years to come.

THE EXPERIMENT

With a nod to Charlie Papazian who conducted a similar experiment (Price 1922), we made 65 gallons of mead in a single session in February 1993. Yeast was obtained through Yeast Lab (M61-dry mead and M62-sweet mead) or The Yeast Culture Kit Co. (Epernay, Prisse de Mousse, Riesling and Tokay) and were pure cultures from slants or normal production runs in the case of Yeast Lab M61 and M62. Honey was obtained locally or by [illegible] in each case we attempted to p[illegible]ast-processed form. In many c[illegible] tered and unprocessed, there[illegible] handling crystallized bricks rathe[illegible] uids. All meads except batch No. 1[illegible] made to the same recipe: 2 1/2 pounds p[illegible] gallon (0.3 kilograms per liter) of honey, two-fifths teaspoon per gallon (1.1 milliliter per liter) of malic acid, two-fifths teaspoon per gallon (1.1 milliliter per liter) of tartaric acid, two-fifths teaspoon per gallon (1.1 milliliter per liter) of yeast nutrient and one-fifth teaspoon per gallon (0.6 milliliter per liter) of Yeast Energizer. Original gravity fell in the range of 1.092 to 1.094, pH 3.55 to 4.0, titratable acidity 0.2 to 0.25 (expressed as tartaric acid equivalents). For the blended batch (No. 13) we added all the remaining honey

Making Melomel

ADDING FRUIT TO MEAD MAKES MELOMEL. Raspberries, blackberries and pit fruits are popular, but almost any fruit will do and creativity has its rewards. Depending on the amount of fruit character you desire, you can add one to three pounds of fruit per gallon (0.12 to 0.36 kilograms per liter). Most fruit can simply be mashed with a potato masher. Peaches, nectarines and plums should be chopped. There are several ways to add fruit, each with advantages and disadvantages. The idea is to add the fruit without sacrificing sanitation. Here are a few methods.

METHOD ONE: Add fruit before fermentation. This requires very effective sanitation because the must is most susceptible to infection at this stage. Although it cuts against the grain of current wisdom, the use of a plastic fermenter can be very effective here. Follow the basic mead recipe, sanitizing your immersion chiller during the water boil. Add the fruit to the sanitized fermenter while the honey and water are sanitizing. Put the immersion chiller in your fermenter with the fruit and pour the hot honey mixture over. Cover with aluminum foil and allow to sanitize for 20 minutes, then turn on the immersion chiller. Pitch yeast when the wort is 70 degrees F (21 degrees C), and rack off fruit when fermentation slows, usually about two to four weeks. Follow bottling instructions as before.

METHOD TWO: Add fruit after primary fermentation. Your mead is still susceptible here, so this method also requires sanitation of the fruit (sulfite, blanch or pasteurize). Ferment must according to the basic recipe, but decrease your water to 3 1/2 gallons (13.25 liters). When you are ready to transfer to the secondary, sanitize your immersion chiller in a pot of boiling water. Pour off all but one-half gallon of water and add fruit. Raise the temperature of the fruit mix to 170 degrees F (77 degrees C) for 10 minutes, then turn on the chiller. When the temperature has dropped below 80 degrees F (27 degrees C), add the fruit to a six- or seven-gallon (23- or 26.5-liter) fermenter and rack the must onto the fruit. Rack the mead again when signs of the ensuing fermentation have slowed.

METHOD THREE: Add rinsed raw fruit after secondary fermentation. Your mead will be at its most stable stage after secondary fermentation, and adding raw fruit will give you the best chance of capturing its freshness, aroma and flavor in as pristine a condition as possible. Add the fruit to a six- or seven-gallon (23- or 26.5-liter) fermenter and rack the mead onto the fruit. Rack when fermentation ceases.

MELOMEL ADDS A TREMENDOUS VARIETY TO THE RANGE OF MEADS YOU CAN MAKE. We are curious about the results of brewing fruit melomels from their respective honeys: raspberry melomel with raspberry honey, or orange melomel with orleftovers and then diluted with water to obtain an original gravity of 1.130. The procedure was the same for all batches: we brought the proper amount of acid-treated water to a boil, added the honey and allowed it to pasteurize for 15 minute at 160 to 170 degrees F (71 to 77 degrees C), cooled to 70 degrees F (21 degrees C) and put the must into a carboy.

We began around 10:30 a.m. using four 15 1/2-gallon (59-liter) stainless-steel kettles equipped with either propane or natural gas burners. Crystallized honey proved to be difficult to work with on the 65-pound (29.5-kilogram) scale. After a short dinner break at 8 p.m. we had everything washed by 9 p.m., all carboys carried down to the basement and the yeast cultures pitched by 9:30 p.m. Arranging and re-arranging the carboys on the floor so they sat on an insulating layer of Styrofoam® produced a pleasing array of hues that ranged from almost water-clear (star thistle) to amber (wildflower).

Fermentations all were active within 12 hours and were allowed to proceed at ambient temperature. Active fermentation is a relative term, but with proper nutrition and an adequate pitching rate one can expect up to two bubbles per minute in an S-shaped air lock. The ambient temperature ranged from 50 to 70 degrees F (10 to 21 degrees C) depending on the season, and was complete by the end of summer (about six months later). We made no attempt to achieve a rapid fermentation in this experiment. Two of the batches spontaneously cleared at seven months: the clover meads fermented with Epernay and Prisse de Mousse yeast. All were treated with bentonite and racked to secondary in April 1994. No further clarification was seen, so Sparkolloid® was added to all of the carboys. Absolute clarity was observed within four days in all batches. The individual batches were racked to kegs in June 1994, blanketed with CO_2 and allowed to condition at cellar temperatures. All of the meads were sampled at 18 months of age, admittedly young for a mead. Many would benefit from additional age. Flavors (especially the wildflower) will mellow and the aroma will improve. Here are our tasting notes:

Honey	Yeast	OG	FG
Clover	Prisse de Mousse	1.094	0.992
Comments:	*Extremely dry, austere. Honey character evident. Alcohol evident.*		
Clover	M61-dry mead	1.094	1.000
Comments:	*Dry, crisp but with good honey expression. Neutral character.*		
Clover	Riesling	1.094	1.007
Comments:	*Off-dry, fruity with honey emphasis.*		
Clover	M62-sweet mead	1.094	1.009
Comments:	*Off-dry, good honey aroma.*		
Clover	Epernay	1.094	1.011
Comments:	*Sweet, soft, fruity. Some sulfur aroma.*		
Clover	Tokay	1.094	1.015
Comments:	*Sweet, good honey aroma*		
Wildflower	M61-dry mead	1.094	0.995
Comments:	*Young wildflower mead taste, needs more time to mellow. Rough at this point.*		
Fireweed	M61-dry mead	1.091	1.000
Comments:	*Very mild, slightly floral flavor, aroma.*		
Wild raspberry	M61-dry mead	1.094	1.010
Comments:	*Unique, perfumy flavor, aroma. Strong unique honey flavor.*		
Orange blossom	M61-dry mead	1.093	1.019
Comments:	*Mild, mellow, excellent floral-citrus flavor.*		
Snowberry	M61-dry mead	1.095	1.021
Comments:	*Very nice, resinous, evergreen quality. Unique honey character.*		
Star thistle	M61-dry mead	1.092	1.015
Comments:	*Mild, pleasant flavor. Some sulfur notes present.*		

Yeast Ava
FOR THE
Meadmaker

THIS IS BY NO MEANS an exhaustive list, but represents most of the commonly available strains.

DRY YEAST

Red Star
- Pasteur Champagne
- Epernay
- Montrachet
- Prisse de Mousse

Lalvin
- EC-1118 (higher alcohol tolerance)
- 71B-1122
- K1V-1116 ("Killer" Yeast)
- ICV/D-47
- Red Burgundy

LIQUID YEAST

Yeast Lab
- M61 Dry Mead — Pasteur Champagne (14-16% ETOH tolerance)
- M62 Sweet Mead — Steinberger (12-13% ETOH tolerance)

Wyeast
- #3632 Dry Mead — Prisse de Mousse (12-14% ETOH tolerance)
- #3184 Sweet Mead — Redeisheiner (9-11% ETOH tolerance)

SLANTS

The Yeast Culture Kit Co.
- W2 Pasteur Champagne
- W5 White wine #1
- W6 Champagne
- W7 White wine #2
- W8 Epernay
- W9 Tokay
- W10 Sauternes
- W11 Prisse de Mousse
- W12 Steinberger
- W13 Mead
- W14 Sherry
- W15 Montrachet
- W16 Chablis
- W17 Bordeaux
- W18 Burgundy
- W19 Riesling #1
- W20 Riesling #2

GLOSSARY

Brix – A scale for measuring sugar content based on the Balling scale.

Lees – Spent yeast on the bottom of the fermenter.

Must – Unfermented honey and water.

Off-dry – A wine evaluation term that refers to a wine that has 0.5 to 1 percent residual sugar, not sweet but not bone dry.

Show mead – The old English term for a fermented mixture of honey and water.

Traditional mead – Though primarily honey and water, traditional mead may also contain trace flavorings and spices designed to enhance flavor rather than provide pronounced flavoring.

Titratable Acidity – (TA) A common winemakers term that refers to the amount of acid titrated against a known standard base.

Yeast Extract – Yeast nutrient. Yeast extract is the contents of the yeast cell. Yeast is cultured specifically for this purpose and is centrifuged separating the cell wall skeletons (also called hulls or ghosts) from the extract.

Yeast Hulls – Skeletons of a yeast cell wall. Also called ghosts. See Yeast Extract.

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