Good mead with Di-Hydrogen Monoxide – Water the odds?

An empirical test of four water profiles used to make a traditional mead with Bee Seasonal's Acacia-Angico honey from Brazil.

Water chemistry for Mead

These meads were fermented under nearly identical conditions with mineral salts being the variable.

YOU can decide which water profile makes the most desirable mead. Samples provided. Did I get your attention? Yes, samples provided!

Kevin Meintsma

- Enthusiastic amateur beer, cider and wine maker for the past 30+ years.
- Started making mead at the end of 2017 to find some new challenges.
- Process and technique sciency geek.
- Member of the AMMA Home Governing Committee.
- "Permanent" guest host on the GotMead Live podcast with Vicky Rowe and A.J. Ermenc.
- Executive director of the Valkyries Horn Mead Competition (amateur and commercial).

• Premise:

- This experiment was intended to discover if water chemistry makes a material difference in the aroma and flavor characteristics of traditional mead. If it does, the ultimate goal is to start refining water profiles to find the adjustment sweet spot for:
- Different types of honey (light/floral, dark/minerally, etc.)
- Fruit (citrus, tropical, bramble, etc.)
- Spices (subtle, powerful, bright, earthy, etc.)



- A huge word of thanks to Bee Seasonal for donating the honey needed to complete this project.
- And... thanks to the AMMA board for material support and encouragement!

- The recipe for all four meads looks like this:
- 14.25# (6.6 kg)(~1.19 gallons) Bee Seasonal Organic Acacia-Angico Blossom honey
- 4.75 gallons (18 L) Water (RO, Hard, Balanced, Full/Sweet)
- 5.68 grams OptiWhite (SIY Specific Inactivated Yeast)
- 3.41 grams FT Blanc Soft (fermentation tannin)
- 13.11 grams BA 11 yeast (~2.2 gr / 3.8 L)
- 16.39 grams GoFerm Protect in 325ml RO water
- 30 grams Fermaid O (split into 4 additions with 145ml RO water for each)
- 1.089 to 1.090 O.G. (original gravity)
- 6 Gallons net liquid volume

• Samples...

• We have some volunteers that will be passing sample cups of the four different meads down the rows. Please make sure you get one of each along with the sensory data paper.

There will be a test at the end...

Sensory data collection:

					В	LUE		
	Ra	nge	e (L	to	H)	Charac	teristic	Notes?
Aroma	0	0	0	0	0	Floral		
	0	0	0	0	0	Spicy		
	0	0	0	0	0	Fruity		
	0	0	0	0	0	Herbac	eous	
	0	0	0	0	0	Nutty		
	0	0	0	0	0	Carame	el	
	0	0	0	0	0	Woody		
	0	0	0	0	0	Earthy		
Flavor	0	0	0	0	0	Floral		
	0	0	0	0	0	Spicy		
	0	0	0	0	0	Fruity		
	0	0	0	0	0	Herbac	eous	
	0	0	0	0	0	Nutty		
	0	0	0	0	0	Carame	el	
	0	0	0	0	0	Woody		
	0	0	0	0	0	Earthy	0	
Mouthfeel	0	0	0	0	0	Thin		
	0	0	0	0	0	Full		
	0	0	0	0	0	Slick		
	0	0	0	0	0	Dry		
Match the	sar	npl	e.	F	20	Hard	Bal	Full 🖌

A single word here is helpful if you want to add a note. For instance; pear, anise, oak, etc.

It's a game! Match the water chemistry to the color of the sample in your cup.

• RO Water:

Sample ID : RO

	\frown
pH	5.9
Total Dissolved Solids (TDS) Est, ppm	12
Electrical Conductivity, mmho/cm	0.02
Cations / Anions, me/L	0.2 / 0.1
	ppm
Sodium, Na	3
Potassium, K	< 1
Calcium, Ca	0.2
Magnesium, Mg	< 1
Total Hardness, CaCO3	< 1
Nitrate, NO3-N	0.1 (SAFE)
Sulfate, SO4-S	< 1
Chloride, Cl	1
Carbonate, CO3	< 1.0
Bicarbonate, HCO3	4
Total Alkalinity, CaCO3	3
Total Phosphorus, P	< 0.01
Total Iron, Fe	< 0.01
	"<" - Not Detected / Below Detection Limit

• Hard Water:

Sample ID : CARBON W HARD

	\frown
рН	7.8
Total Dissolved Solids (TDS) Est, ppm	407
Electrical Conductivity, mmho/cm	0.68
Cations / Anions, me/L	6.9 / 6.7
	ppm
Sodium, Na	16
Potassium, K	4
Calcium, Ca	71.3
Magnesium, Mg	30
Total Hardness, CaCO3	303
Nitrate, NO3-N	0.2 (SAFE)
Sulfate, SO4-S	2
Chloride, Cl	20
Carbonate, CO3	< 1.0
Bicarbonate, HCO3	367
Total Alkalinity, CaCO3	302
Total Phosphorus, P	0.55
Total Iron, Fe	0.03
	"<" - Not Detected / Below Detection Limit

• Balanced (1):

Desired Water Profile Calcium (ppm) Calcium (ppm) Solution (ppm) Solution (ppm) Solution (ppm) Chance is placeboards (ppm) Approximate Color Descriptors for Varier Profile Batch Note: F Batch Not									1. 1. 1.					1				
Mead Balanced 50 5 4 30 30 100 Yellow: under 6 SRM Existing Water Profile 0	Desired Water Profile		Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)	Approximate W	e Color Des ater Profiles	criptors for S		Batch Note	s				
Existing Water Profile 0 0 0 0 0 0 Amber 7 to 17 SRM Brown 18 to 30 SRM Brown 18 to 30 SRM RO Water 10 0 8 1 4 16 Black over 31 SRM Percent Dilution Water Profile 10 28 0/gal < These orwesions are provided for your convenience In et any noles for the batch or the calculation here. Diluted Water Profile 1 0 8 1 4 16 Mashing Water Adjustment (pm 49 5 4 29 26 84 Actual Finished Water Adjustment (pm 49 5 8 300 31 0 0 100 100 100 100 100 100 100 100 100 100 100 100 100 100	Mead Balanced		50	5	4	30	30	100	Yellov	w: under 6 S	SRM							
Bituition Water Profile Bituition Water Profile Bituition Water Profile Inter Profile Bituition Water Profile Inter Profile <th cols<="" td=""><td>Existing Water Profile</td><td>10</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Ambe</td><td>er: 7 to 17 S</td><td>RM</td><td></td><td></td><td></td></th>	<td>Existing Water Profile</td> <td>10</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>Ambe</td> <td>er: 7 to 17 S</td> <td>RM</td> <td></td> <td></td> <td></td>	Existing Water Profile	10	0	0	0	0	0	0	Ambe	er: 7 to 17 S	RM						
RO Water 1 0 8 1 4 16 Black our 31 SRM Inst day, notes for the balk of	Dilution Water Profile								Brown					10 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -				
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Actual Finished Water Adjustment (ppm) 48 5 0 29 27 87 Mashing Water Profile 49 5 8 30 31 103 000 100 Overall Finished Water Profile 49 5 8 300 31 103 0.00 100 <	Target Finished Water A	djustment (ppm)	49	5	-4	29	26	84										
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Gypsum (CaSO ₄ × 2H ₂ O) 0.06 3.7 0 8.8 0 0.06 0.00 Calcium Chloride (CaCl ₂) 0.16 15.3 0 27.0 0.16 0.00 Anhydrow Math form Epsom Salt (MgSO ₄ × 7H ₂ O) 0.20 5.2 20.6 0.0 0.20 0.00 10.0 Liquid Ca Magnesium Chloride (MgCl ₂ × 6H ₂ O) 0.00 0.00 0.00 0.00 0.00 0.00 10.0 Liquid Ca Canning Salt (MgCl) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 Add Sparg Baking Soda (NaHCO ₃) 0.00 0.0 0.0 0.0 0.00 Not Recommended No Add Sparg Chalk (CaCO ₃) 0.00 0.00 0.0 0.00 Not Recommended No Add CaSO Sodium Metabisuffite (Na ₂ SO ₃) 0.00 28.6 0.0 0.0 0.00 0.00 Add CaSO	Minerals	Addition (gram/gal)	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)	Total Mineral (gram	Additions ns)	Total Miner (gra	al Additions ims)						
Calcium Chloride (CaCl2)0.1615.327.00.160.06AnhydrousWhat form Liquid CalcaEpsom Salt (MgSQ $_{\lambda}$ X H2O)0.200.205.220.620.60.00.200.0010.010	Gypsum (CaSO ₄ x 2H ₂ O)	0.06	3.7			8.8			0.06	5	0.	00		17				
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Canning Salt (NaC) 0.00 <td>Magnesium Chloride (MgCl₂ x 6H₂O)</td> <td>0.00</td> <td></td> <td>0.0</td> <td></td> <td></td> <td>0.0</td> <td></td> <td>0.00</td> <td>)</td> <td>0.</td> <td>00</td> <td>Lic</td> <td>uid CaCl₂ Sol</td>	Magnesium Chloride (MgCl ₂ x 6H ₂ O)	0.00		0.0			0.0		0.00)	0.	00	Lic	uid CaCl ₂ Sol				
Baking Soda (NaHCO3) 0.00 0.00 0.00 Not Recommended Add Spain additions Chalk (CaCO3) 0.00 0.00 0.00 0.00 0.00 Not Recommended No Add Spain additions Chalk (CaCO3) 0.00 0.00 0.00 0.00 0.00 Not Recommended No Add Spain additions Pickling Lime (Ca(OH)2) 0.20 28.6 0.0 0.0 87.0 0.20 Not Recommended No Add CaSC Sodium Metabisulfite (Na2SO3) 0.00 0.00 0.0 0.00 0.00 0.00 0.00	Canning Salt (NaCl)	0.00			0.0		0.0		0.00)	0.	00						
Chalk (CaCO ₃) 0.00 0.0 0.0 0.00 Not Recommended No Add Hard Pickling Lime (Ca(OH) ₂) 0.20 28.6 Image: Calify the state of th	Baking Soda (NaHCO3)	0.00			0.0			0.0	0.00)	Not Reco	mmended	No	additions to				
Pickling Lime (Ca(OH) ₂) 0.20 28.6 Image: Calify and the content of the content o	Chalk (CaCO ₃)	0.00	0.0					0.0	0.00)	Not Reco	mmended	No	Add Hardne				
Sodium Metabisulfite (Na ₂ S ₂ O ₅) 0.00 0.0 0.0 0.0 0.0 0.00 0.00 0.00	Pickling Lime (Ca(OH) ₂)	0.20	28.6					87.0	0.20)	Not Reco	mmended	No	Add CaSO4				
	Sodium Metabisulfite (Na ₂ S ₂ O ₅)	0.00	< ppm		0.0	0.0			0.00)	0.	00		- a cime in 3p				

• Balanced water - First try results:

Sample ID : BALANCED

	\frown
pH	8.1
Total Dissolved Solids (TDS) Est, ppm	192
Electrical Conductivity, mmho/cm	0.32
Cations / Anions, me/L	2.6 / 2.6
	ppm
Sodium, Na	4
Potassium, K	1
Calcium, Ca	37.6
Magnesium, Mg	7
Total Hardness, CaCO3	124
Nitrate, NO3-N	0.1 (SAFE)
Sulfate, SO4-S	17
Chloride, Cl	25
Carbonate, CO3	< 1.0
Bicarbonate, HCO3	52
Total Alkalinity, CaCO3	43
Total Phosphorus, P	< 0.01
Total Iron, Fe	< 0.01
	"<" - Not Detected / Below Detection Limit

• Water – Balanced-2 (second try) results:

Sample ID : BALANCED 2

	\frown							
pH	7.9							
Total Dissolved Solids (TDS) Est, ppm	178							
Electrical Conductivity, mmho/cm	0.28			Hover	cursor over cells w/	red corner marks to	to dieplay holpful in	formation
Cations / Anions, me/L	2.8/2.7	Water Adjustment Sum	mary	Magazetium (nom)	Codium (nom)	Cullate (nam)	Chlorida (com)	Disarba
		Existing Water Profile	Calcium (ppm)	0	0	Ounaie (ppin)	O O	Dicarbo
		Mashing Water Profile	56	5	8	44	34	1
	ppm	Finished Water Profile	56	5	8	44	34	
Sodium, Na	4	Recommended Ranges	20 to 150	0 to 30	0 to 150	0 to 350	0 to 100	as n
Determine K		Mash Parameters				1		
Potassium, K	< 1	Batch Volume (gallons) 1.00	Hardness (p	pm as CaCO₃)	161	RA (ppm	as CaCO ₃)	
Calcium, Ca	42.6	Estimated Mash pH 5.00	Aikalinity (pp	om as CaCO ₃)	84	504/0	JI Katio	
Magnesium, Mg	6		Total Mash V	Water Vol (gal)	1.00	Total Sparge	Water Vol (gal)	0
Total Hardness CaCOs	133	Additions	Mash Dilut	tion Vol (gal)	1.00	Sparge Dilu Spa	ution Vol (gal)	0
	O A (OAFE)	Minerals		(grams)			(grams)	
Nitrate, NO3-N	0.1 (SAFE)	Gypsum (CaSO4 x 2H ₂ O)		0.2			0.0	
Sulfate, SO4-S	18	Calcium Chloride (CaCl ₂) Anhydrous		0.2			0.0	
Chloride Cl	25	Magnesium Chloride (MgCl ₂)		0.0			0.0	
		Canning Salt (NaCl)		0.0			0.0	
Carbonate, CO ₃	< 1.0	Baking Soda (NaHCO ₃) Chalk (CaCO ₃)		0.0		N	ot Recommend	led
Bicarbonate, HCO3	48	Pickling Lime (Ca(OH) ₂)		0.2		N	lot Recommend	led
Total Alkalinity, CaCO3	40	Sodium Metabisulfite (Na ₂ S ₂ O ₅)		0.0			0.0	
Total Phosphorus, P	0.13							
Total Iron, Fe	< 0.01							

Bicarbonate (ppm) 0 103 NA

as needed

41 1.3 0.00 0.00

"<" - Not Detected / Below Detection Limit

• Water – Full/Sweet-2 (second try) results:

Sample ID : SWEET 2

	\frown	
pH	8.1	
Total Dissolved Solids (TDS) Est, ppm	259	
Electrical Conductivity, mmho/cm	0.43	
Cations / Anions, me/L	3.4 / 3.5	1
	ppm	1
Sodium, Na	4	
Potassium, K	1	1
Calcium, Ca	51.1	E
Magnesium, Mg	8	Ī
Total Hardness, CaCO3	161	1
Nitrate, NO3-N	0.1 (SAFE)	0
Sulfate, SO4-S	11	0
Chloride, Cl	87	
Carbonate, CO3	< 1.0	E
Bicarbonate, HCO3	21	C F
Total Alkalinity, CaCO3	18	9
Total Phosphorus, P	0.01	
Total Iron, Fe	< 0.01	

Water Adjustment Summary

Hover cursor over cells w/ red corner marks to display helpful information

flead Sweet	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)
xisting Water Profile	0	0	0	0	0	0
Aashing Water Profile	65	5	8	23	103	38
inished Water Profile	65	5	8	23	103	NA
Recommended Ranges	20 to 150	0 to 30	0 to 150	0 to 350	0 to 100	as needed

Mash Parameters		-			
Batch Volume (gallons)	1.00	Hardness (ppm as CaCO ₃)	183	RA (ppm as CaCO ₃)	-19
Estimated Mash pH	5.00	Alkalinity (ppm as CaCO ₃)	31	SO4/CI Ratio	0.2

	Total Mash Water Vol (gal)	1.00	Total Sparge Water Vol (gal)	0.00	
Additions	Mash Dilution Vol (gal)	1.00	Sparge Dilution Vol (gal)	0.00	
	Mash Water Additi	ons	Sparge Water Addit	ions	
Minerals	(grams)		(grams)		
Gypsum (CaSO ₄ x 2H ₂ O)	0.2		0.0		
Calcium Chloride (CaCl ₂) Anhydrous	0.5		0.0		
Epsom Salt (MgSO ₄ x 7H ₂ O)	0.0		0.0		
Magnesium Chloride (MgCl ₂)	0.2		0.0		
Canning Salt (NaCl)	0.0		0.0		
Baking Soda (NaHCO ₃)	0.0		Not Recommende	d	
Chalk (CaCO ₃)	0.0		Not Recommended		
Pickling Lime (Ca(OH) ₂)	0.1		Not Recommended		
Sodium Metabisulfite (Na ₂ S ₂ O ₅)	0.0		0.0		

"<" - Not Detected / Below Detection Limit

• Water – side by side summary:

RO Wate	er	Hard Wat	er	Full/Sweet V	Vater	Balanced V	Vater
pH:	5.9	pH:	7.8	pH:	8.1	pH:	7.9
Sodium	3	Sodium	16	Sodium	4	Sodium	4
Calcium	0.2	Calcium	4	Calcium	51.1	Calcium	42.6
Magnesium	0	Magnesium	71.3	Magnesium	8	Magnesium	6
Sulfate	0	Sulfate	2	Sulfate	11	Sulfate	18
Chloride	1	Chloride	20	Chloride	87	Chloride	25
Must pH	3.98	Must pH	5.98	Must pH	4.28	Must pH	4.40
Finished pH	3.24	Finished pH	3.45	Finished pH	3.17	Finished pH	3.21
No addtions		No additions	0	RO gr/1G (3.8	BL):	RO gr/1G (3.8	3L):
				Gypsum	0.2	Gypsum	0.2
				Calc Chloride	0.5	Calc Chloride	0.2
				Magn Chloride	0.2	Epsom Salt	0.2
				Pickling Lime	0.1	Pickling Lime	0.2
. 'T							

• Tasting Notes:

• Some of you undoubtably tasted through all of your samples.

If not, this would be a great time to sample those meads and record your impressions.

• Equipment:



• Presentation:





• Data Collection:



RO Water Fermentation Kinetics



39 days total, 37 days to terminal gravity





40 days total, 32 days to terminal gravity



Full/Sweet Water Fermentation Kinetics



Fermentation Summary:

RO Wate	er	Hard Wat	ter	Full/Swe	et	Balance	d
pH:	5.9	pH:	7.8	pH:	8.1	pH:	7.9
Finished pH	3.24	Finished pH	3.45	Finished pH	3.17	Finished pH	3.21
Final Gravity	1.000	Final Gravity	0.998	Final Gravity	0.997	Final Gravity	0.998
Days to F.G.	37	Days to F.G.	32	Days to F.G.	28	Days to F.G.	29



- The results were NOT what I was expecting. In most respects, that's a good thing.
- Personal observation: differences are present, but very subtle.
 - Can anyone pick out the differences in a blind test?
 - Can anyone correctly identify the sample in a blind test?
- Does the water chemistry matter?
 - It seems that flavor and aroma impact are negligible, although this is a small sample size.
 - However, it does seem to have a significant impact on fermentation kinetics and finishing pH.
 - Different types of honey and/or ingredients might make a difference. Opportunity for another round of experiments?
- Please hand your tasting sheets to our volunteers before you leave the room and the results will be collated and attached as a reference to the presentation. And incidently... The sample colors to water profile are:
- YELLOW = HARD, RED = BALANCED, GREEN = RO, BLUE = FULL/SWEET

References and resources:

- Bru'n Water:
- <u>https://www.brunwater.com/</u>
- Tilt:
- <u>https://tilthydrometer.com/</u>
- Unitank fermenters and Glycol chiller:
- <u>https://www.ssbrewtech.com/</u>
- Yeast mineral requirements: