

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.)

- **Thank You:**



- 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:**

BLUE							
	Range (L to H)					Characteristic	Notes?
Aroma	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Floral	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Spicy	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Fruity	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Herbaceous	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Nutty	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Caramel	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Woody	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Earthy	
Flavor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Floral	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Spicy	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Fruity	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Herbaceous	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Nutty	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Caramel	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Woody	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Earthy	
Mouthfeel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Thin	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Full	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Slick	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Dry	
Match the sample:	RO	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

pH	5.9
Total Dissolved Solids (TDS) Est, ppm	12
Electrical Conductivity, mmho/cm	0.02
Cations / Anions, me/L	0.2 / 0.1

	<u>ppm</u>
Sodium, Na	3
Potassium, K	< 1
Calcium, Ca	0.2
Magnesium, Mg	< 1
Total Hardness, CaCO ₃	< 1
Nitrate, NO ₃ -N	0.1 (SAFE)
Sulfate, SO ₄ -S	< 1
Chloride, Cl	1
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	4
Total Alkalinity, CaCO ₃	3
Total Phosphorus, P	< 0.01
Total Iron, Fe	< 0.01

"<" - Not Detected / Below Detection Limit

• Hard Water:

Sample ID : CARBON W HARD

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	407
Electrical Conductivity, mmho/cm	0.68
Cations / Anions, me/L	6.9 / 6.7

	<u>ppm</u>
Sodium, Na	16
Potassium, K	4
Calcium, Ca	71.3
Magnesium, Mg	30
Total Hardness, CaCO ₃	303
Nitrate, NO ₃ -N	0.2 (SAFE)
Sulfate, SO ₄ -S	2
Chloride, Cl	20
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	367
Total Alkalinity, CaCO ₃	302
Total Phosphorus, P	0.55
Total Iron, Fe	0.03

"<" - Not Detected / Below Detection Limit

Balanced (1):

Desired Water Profile		Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)	Approximate Color Descriptors for Water Profiles	Batch Notes		
Mead Balanced		50	5	4	30	30	100	Yellow: under 6 SRM	Insert any notes for the batch or the calculation here.		
Existing Water Profile		0	0	0	0	0	0	Amber: 7 to 17 SRM			
Dilution Water Profile								Brown: 18 to 30 SRM			
RO Water		1	0	8	1	4	16	Black: over 31 SRM			
Percent Dilution Water	100	128	oz/gal	8	pt/gal	< These conversions are provided for your convenience					
Diluted Water Profile		1	0	8	1	4	16				
Target Finished Water Adjustment (ppm)		49	5	-4	29	26	84				
Actual Finished Water Adjustment (ppm)		48	5	0	29	27	87				
Mashing Water Profile		49	5	8	30	31	103				
Overall Finished Water Profile		49	5	8	30	31	NA	Finished SO ₄ /Cl Ratio 1.0			
Estimated Mash pH		5.00	This pH value is NOT VALID until the grain information is properly entered for the beer on the Grain Bill Input sheet.					Total Water Additions		Total Batch Volume	
Water Additions								Mash	Sparge	Water Volume (gal)	1.00
Minerals		Addition (gram/gal)	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)	Total Mineral Additions (grams)	Total Mineral Additions (grams)	
Gypsum (CaSO ₄ x 2H ₂ O)		0.06	3.7			8.8			0.06	0.00	
Calcium Chloride (CaCl ₂)		0.16	15.3				27.0		0.16	0.00	Anhydrous
Epsom Salt (MgSO ₄ x 7H ₂ O)		0.20		5.2		20.6			0.20	0.00	10.0
Magnesium Chloride (MgCl ₂ x 6H ₂ O)		0.00		0.0			0.0		0.00	0.00	Liquid CaCl ₂ Sol
Canning Salt (NaCl)		0.00			0.0		0.0		0.00	0.00	
Baking Soda (NaHCO ₃)		0.00			0.0			0.0	0.00	Not Recommended	No
Chalk (CaCO ₃)		0.00	0.0					0.0	0.00	Not Recommended	No
Pickling Lime (Ca(OH) ₂)		0.20	28.6					87.0	0.20	Not Recommended	No
Sodium Metabisulfite (Na ₂ S ₂ O ₅)		0.00	< ppm		0.0	0.0			0.00	0.00	Add Spargin additions to 1 Add Hardne: Add CaSO ₄ & Lime in Sp

- Balanced water - First try results:

Sample ID : BALANCED

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, CaCO ₃	124
Nitrate, NO ₃ -N	0.1 (SAFE)
Sulfate, SO ₄ -S	17
Chloride, Cl	25
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	52
Total Alkalinity, CaCO ₃	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

pH **7.9**
 Total Dissolved Solids (TDS) Est, ppm 170
 Electrical Conductivity, mmho/cm 0.28
 Cations / Anions, me/L 2.8 / 2.7

ppm

Sodium, Na 4
 Potassium, K < 1
 Calcium, Ca 42.6
 Magnesium, Mg 6
 Total Hardness, CaCO₃ 133
 Nitrate, NO₃-N 0.1 (SAFE)
 Sulfate, SO₄-S 18
 Chloride, Cl 25
 Carbonate, CO₃ < 1.0
 Bicarbonate, HCO₃ 48
 Total Alkalinity, CaCO₃ 40
 Total Phosphorus, P 0.13
 Total Iron, Fe < 0.01

"<" - Not Detected / Below Detection Limit

Water Adjustment Summary

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

Mead Balanced	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)
Existing Water Profile	0	0	0	0	0	0
Mashing Water Profile	56	5	8	44	34	103
Finished Water Profile	56	5	8	44	34	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)	161	RA (ppm as CaCO ₃)	41
Estimated Mash pH	5.00	Alkalinity (ppm as CaCO ₃)	84	SO ₄ /Cl Ratio	1.3

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

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

Sample ID : SWEET 2

pH **8.1**
 Total Dissolved Solids (TDS) Est, ppm **259**
 Electrical Conductivity, mmho/cm 0.43
 Cations / Anions, me/L 3.4 / 3.5

ppm

Sodium, Na 4
 Potassium, K 1
 Calcium, Ca 51.1
 Magnesium, Mg 8
 Total Hardness, CaCO₃ 161
 Nitrate, NO₃-N 0.1 (SAFE)
 Sulfate, SO₄-S 11
 Chloride, Cl 87
 Carbonate, CO₃ < 1.0
 Bicarbonate, HCO₃ 21
 Total Alkalinity, CaCO₃ 18
 Total Phosphorus, P 0.01
 Total Iron, Fe < 0.01

"<" - Not Detected / Below Detection Limit

Water Adjustment Summary

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

Mead Sweet	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)
Existing Water Profile	0	0	0	0	0	0
Mashing Water Profile	65	5	8	23	103	38
Finished 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
Estimated Mash pH	5.00	Alkalinity (ppm as CaCO ₃)	31
		RA (ppm as CaCO ₃)	-19
		SO ₄ /Cl Ratio	0.2

Additions	Mash Water Additions		Sparge Water Additions	
	Total Mash Water Vol (gal)	Mash Dilution Vol (gal)	Total Sparge Water Vol (gal)	Sparge Dilution Vol (gal)
	1.00	1.00	0.00	0.00
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 Recommended	
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	

- Water – side by side summary:

RO Water		Hard Water		Full/Sweet Water		Balanced Water	
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 additions		No additions		RO gr/1G (3.8L):		RO gr/1G (3.8L):	
				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

- Tasting Notes:

- Some of you undoubtedly tasted through all of your samples.

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

- **Equipment:**



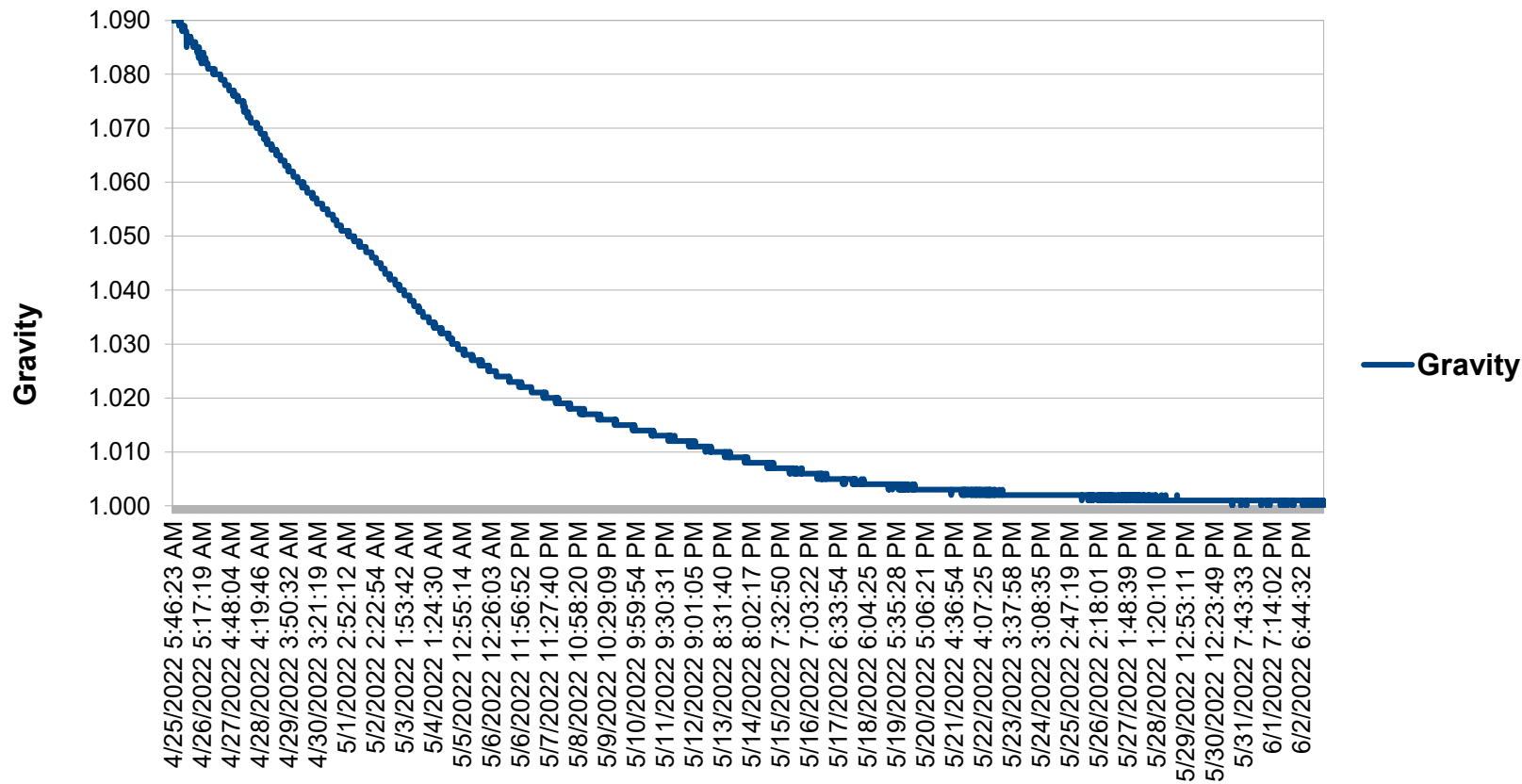
- **Presentation:**



- **Data Collection:**

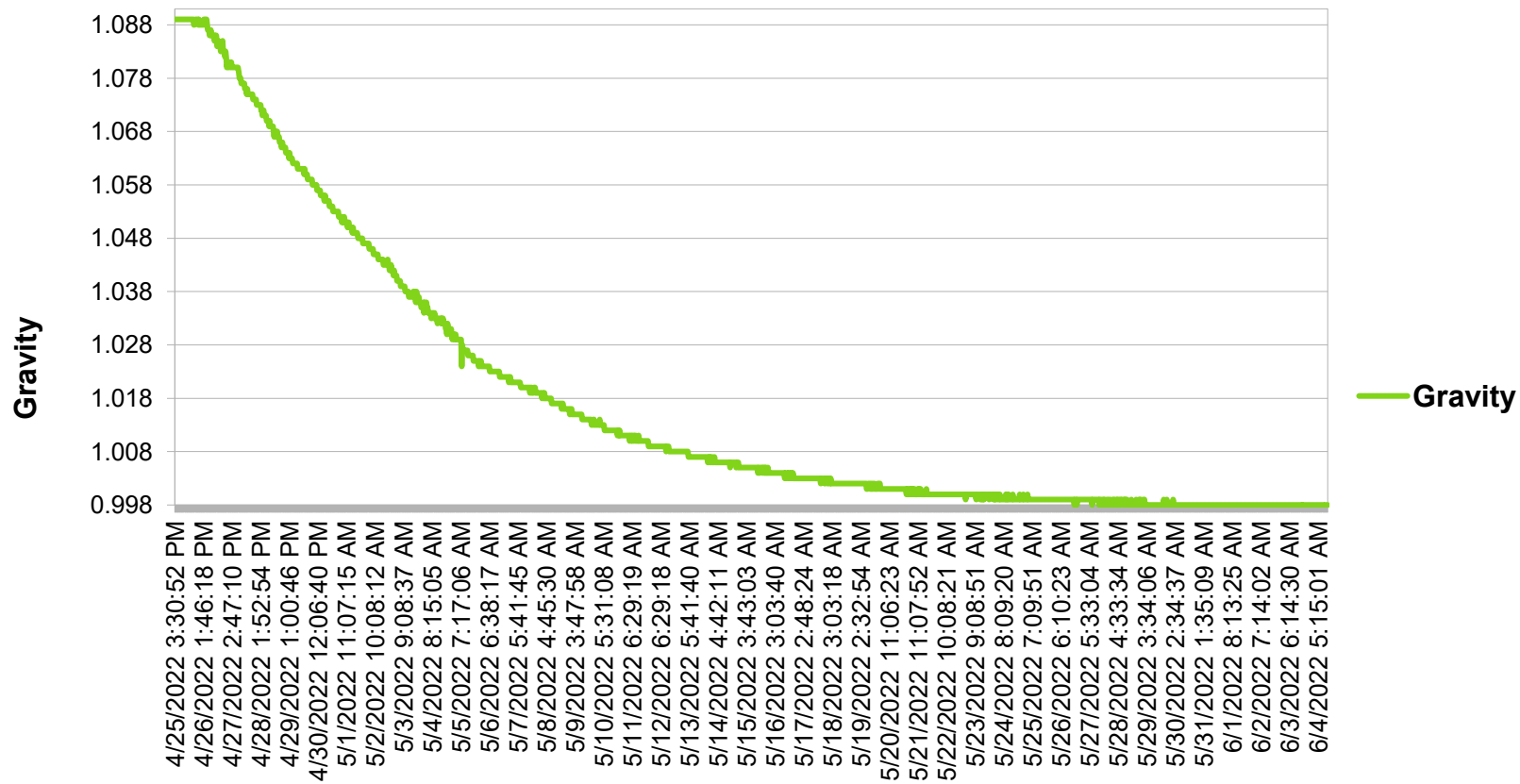


RO Water Fermentation Kinetics



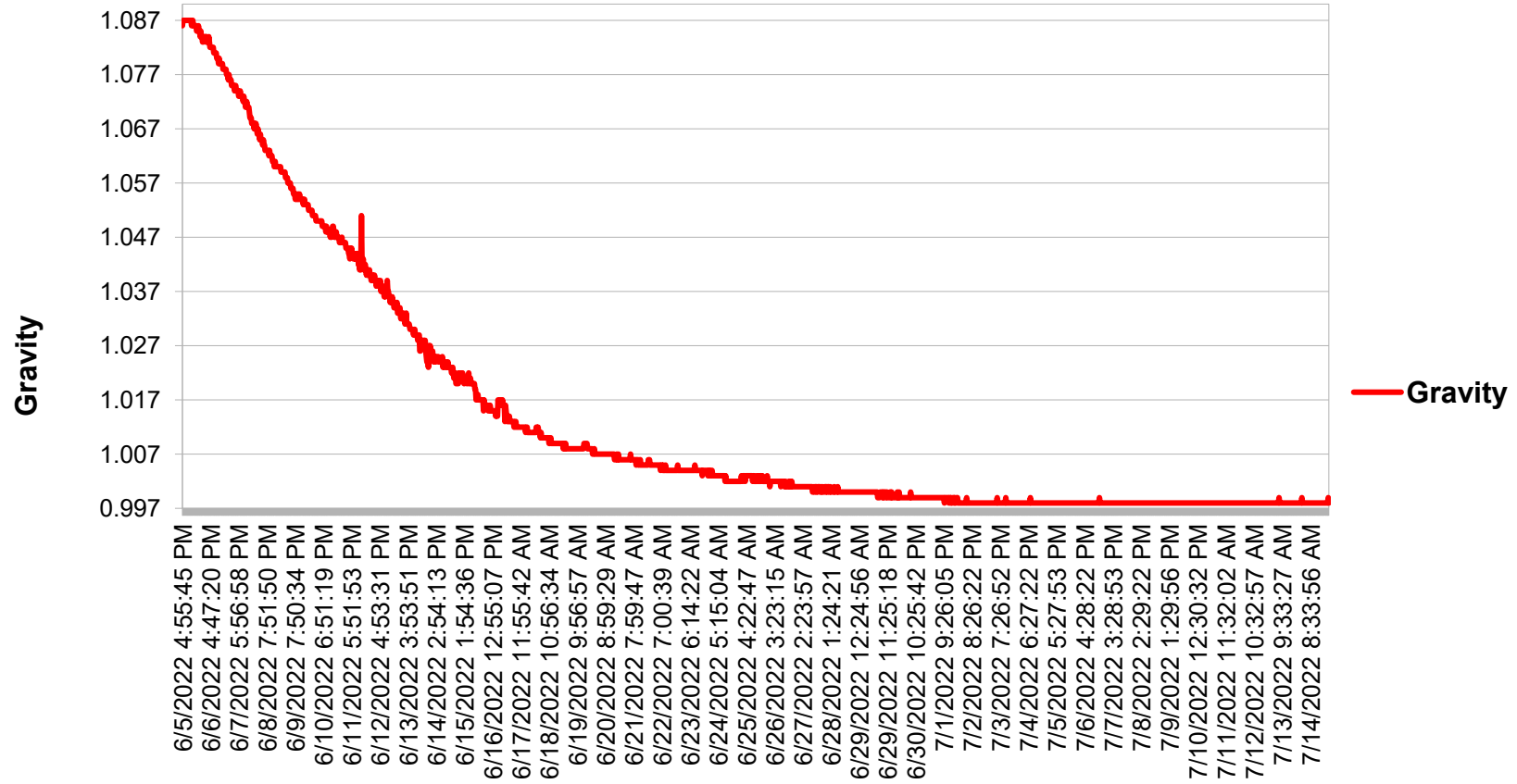
39 days total, 37 days to terminal gravity

Hard Water Fermentation Kinetics



40 days total, 32 days to terminal gravity

Full/Sweet Water Fermentation Kinetics



Timeline 40 days total, 28 days to terminal gravity

Fermentation Summary:

RO Water		Hard Water		Full/Sweet		Balanced	
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

Q&A

- 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:

- <https://www.brunwater.com/>

- Tilt:

- <https://tilthydrometer.com/>

- Unitank fermenters and Glycol chiller:

- <https://www.ssbrewtech.com/>

- Yeast mineral requirements:

- <https://farmfacts.com/nutrient-requirements-of-the-yeast-cell/>