The background of the slide features a subtle, scattered pattern of white water droplets and bubbles of various sizes and shapes, some with soft shadows, against a plain white background.

WATER CHEMISTRY AND BREWING

MHTG

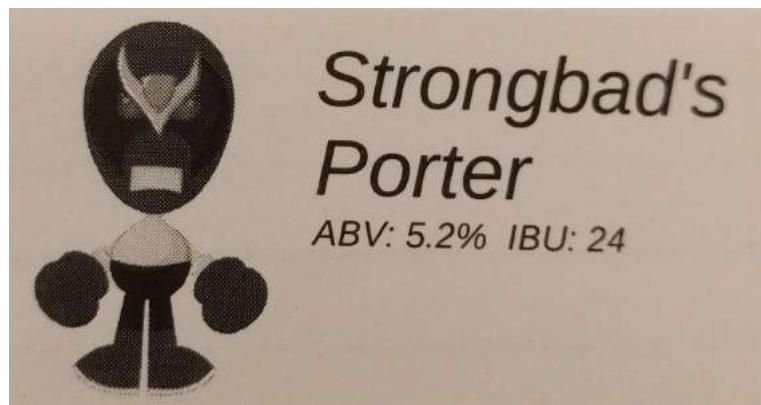
(COLIN CROWLEY, TIM TAUTGES, WITH PLAGIARIZED PARTS FROM MARK
GARTHWAITE)

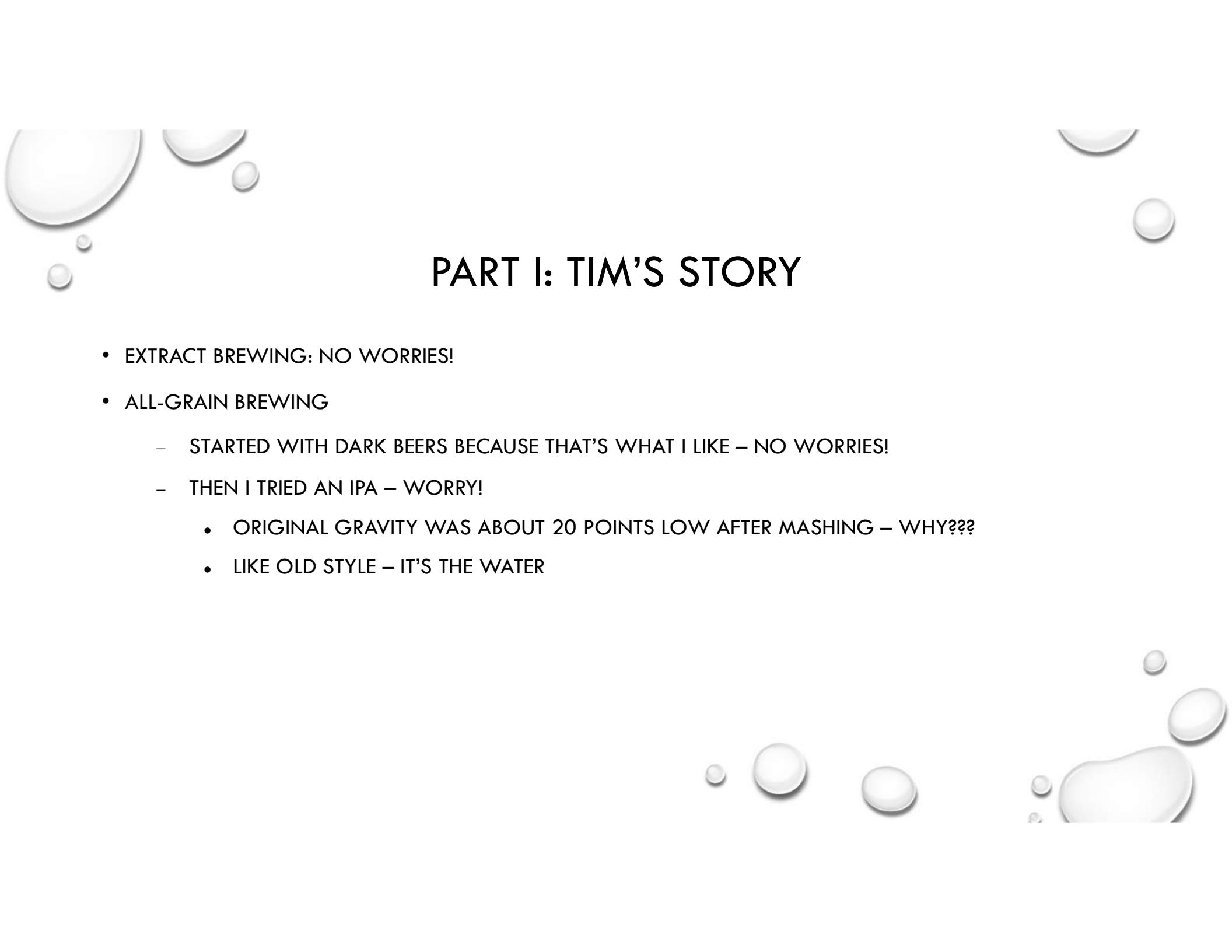


WHY DO WE CARE ABOUT WATER?

- WATER – NOT MUCH - ONLY CARE ABOUT CONCENTRATION/DILUTION – ALTHOUGH IT DOES MATTER FOR MASH EFFICIENCY, HOP UTILIZATION, ETC.
- MINERALS IN WATER, HOWEVER, HAVE TWO MAIN IMPACTS
 - MASH (PART 1 OF TALK)
 - FLAVOR IMPACT IN FINAL BEER (PART 2 OF TALK)
 - EXPERIMENTAL SECTION (I.E. WORK IN PROGRESS) (PART 3 OF TALK)
 - MEADS
 - CIDERS
 - WINES
 - SOURS?

PART I: TIM'S STORY





PART I: TIM'S STORY

- EXTRACT BREWING: NO WORRIES!
- ALL-GRAIN BREWING
 - STARTED WITH DARK BEERS BECAUSE THAT'S WHAT I LIKE – NO WORRIES!
 - THEN I TRIED AN IPA – WORRY!
 - ORIGINAL GRAVITY WAS ABOUT 20 POINTS LOW AFTER MASHING – WHY???
 - LIKE OLD STYLE – IT'S THE WATER

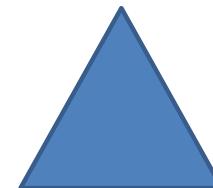
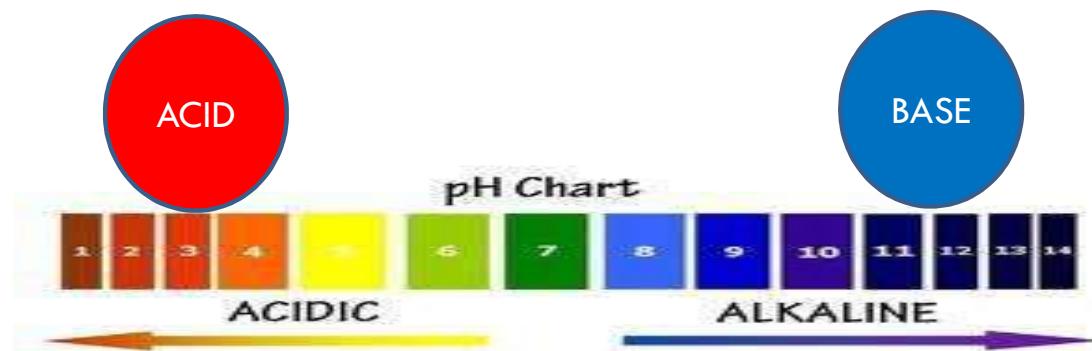
PART I: MASH EXPERIMENT

| Water→ Beer type \ | Tap | RO |
|-----------------------|-----|----|
| IPA (light) | x | x |
| Stout (dark) | x | x |

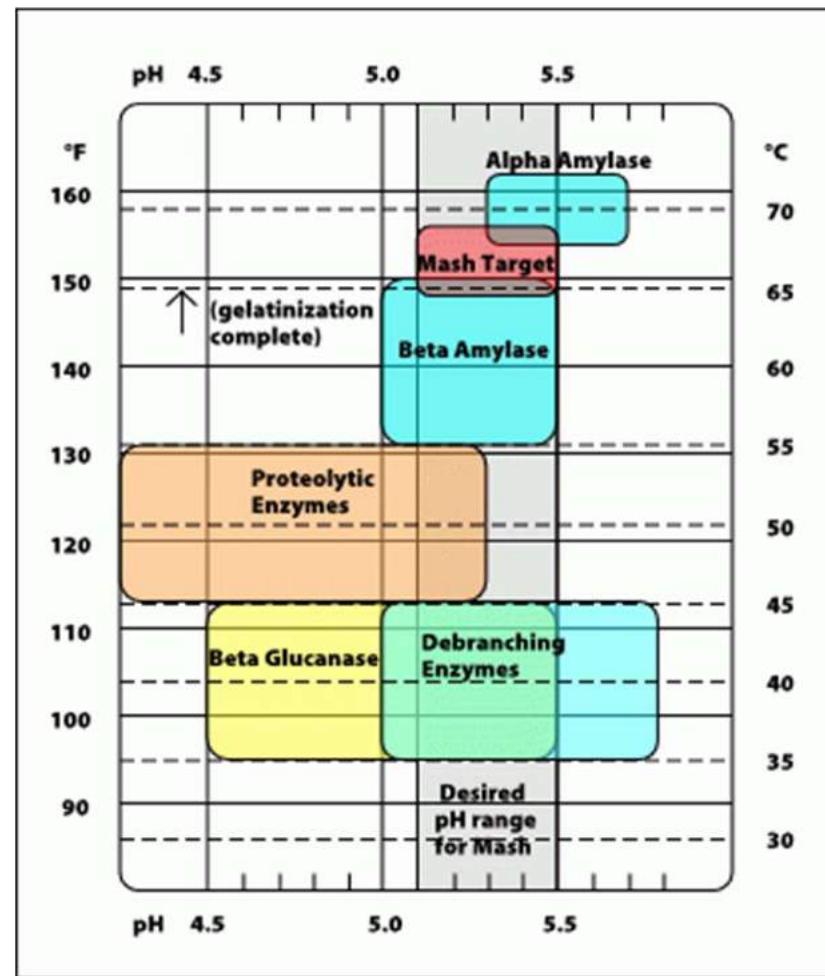
| IPA | Stout |
|-------------------------|---|
| 8 lbs Pale Malt (2 Row) | 4 lbs 12.53 oz Pale Malt (Maris Otter) (69%) |
| 10.31 oz Crystal 40 L | 8.50 oz Biscuit Malt |
| | 8.50 oz Chocolate Malt |
| | 8.50 oz Roasted Barley |
| | 8 oz Lactose |
| 4.82 gallons water | 4.65 gallons water |
| OG: 1.070 | OG: 1.058 |

QUICK TERMS

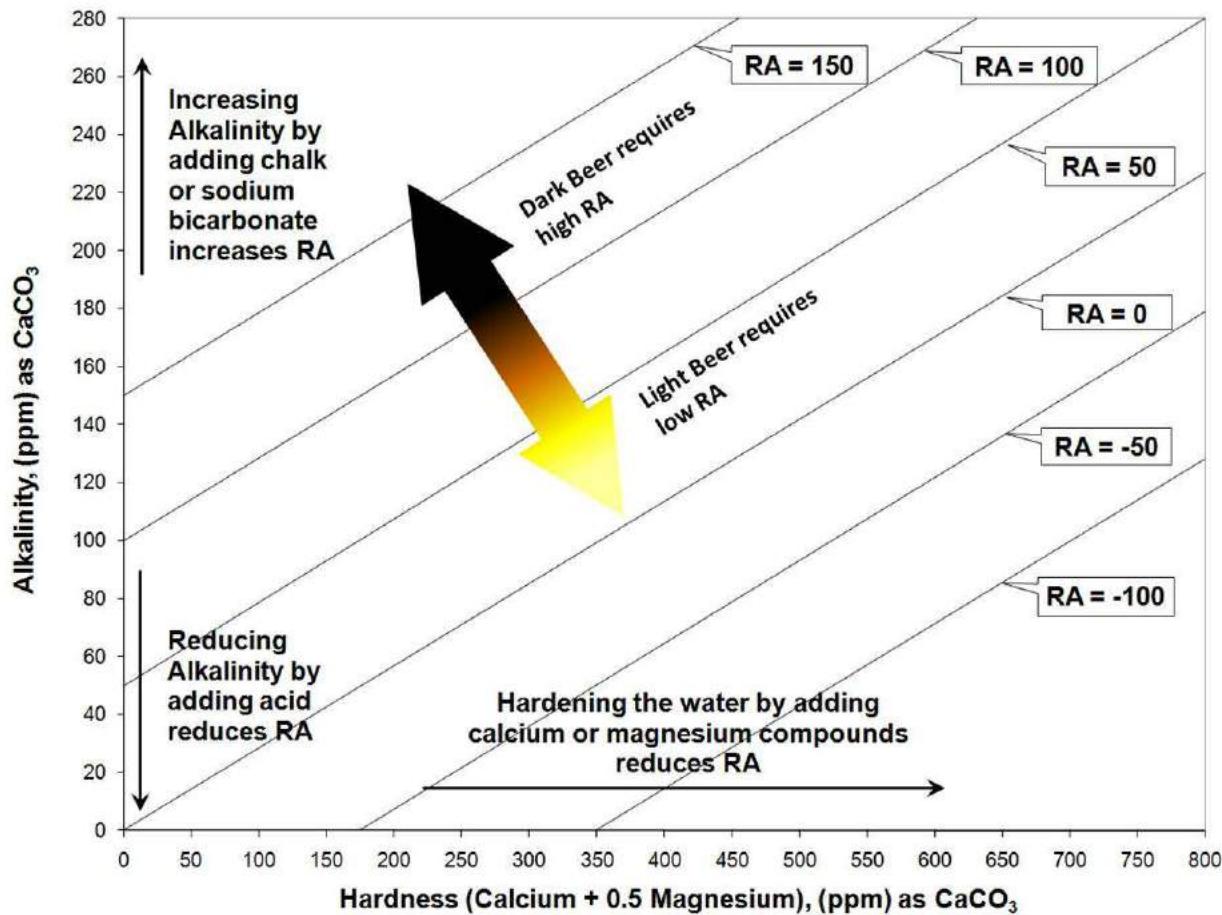
- PH – MEASURE OF HOW ACIDIC (LOW PH) OR ALKALINE (HIGH PH) SOMETHING IS
- TOTAL ACIDITY/ALKALINITY – HOW MUCH RESISTANCE THERE IS TO CHANGE PH

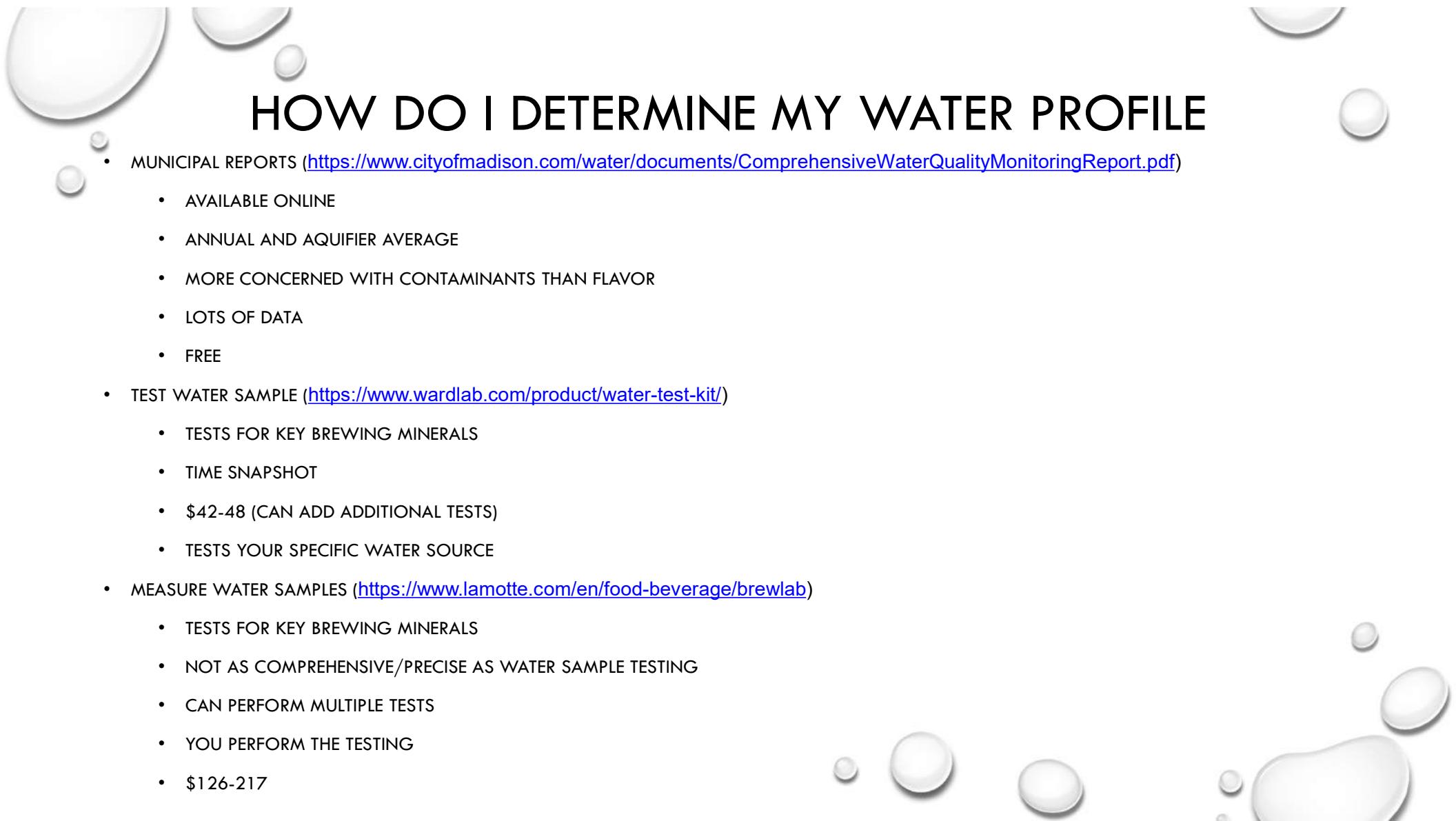


HOW DOES THIS AFFECT MASH?



DIFFERENT GRAINS HAVE DIFFERENT ACIDITY





HOW DO I DETERMINE MY WATER PROFILE

- MUNICIPAL REPORTS (<https://www.cityofmadison.com/water/documents/ComprehensiveWaterQualityMonitoringReport.pdf>)
 - AVAILABLE ONLINE
 - ANNUAL AND AQUIFER AVERAGE
 - MORE CONCERNED WITH CONTAMINANTS THAN FLAVOR
 - LOTS OF DATA
 - FREE
- TEST WATER SAMPLE (<https://www.wardlab.com/product/water-test-kit/>)
 - TESTS FOR KEY BREWING MINERALS
 - TIME SNAPSHOT
 - \$42-48 (CAN ADD ADDITIONAL TESTS)
 - TESTS YOUR SPECIFIC WATER SOURCE
- MEASURE WATER SAMPLES (<https://www.lamotte.com/en/food-beverage/brewlab>)
 - TESTS FOR KEY BREWING MINERALS
 - NOT AS COMPREHENSIVE/PRECISE AS WATER SAMPLE TESTING
 - CAN PERFORM MULTIPLE TESTS
 - YOU PERFORM THE TESTING
 - \$126-217

LOCAL WATER PROFILES

| | RO | Madison Hard Municipal Data | Madison Hard Lab Data | Madison Soft Calculated |
|-------------|----|--------------------------------|--------------------------|----------------------------|
| Calcium | 1 | 70 | 69.6 | 3 |
| Magnesium | 0 | 41 | 37 | 2 |
| Sodium | 8 | 9 | 9 | 151 |
| Sulfate | 1 | 21 | 4 | 21 |
| Chloride | 4 | 19 | 15 | 19 |
| Bicarbonate | 16 | 364 | 344 | 364 |
| Alkalinity | 13 | 302 | 283 | 302 |
| Hardness | 3 | 259 | 329 | 12 |



Ag Testing - Consulting

Account No. : 64731

Water Analysis Report

CROWLEY, COLIN
834 N BRISTOL ST
SUN PRAIRIE
WI 53590

Invoice No. : 1316404
Date Received : 05/15/2020
Date Reported : 05/18/2020

Lab Number : 3684

Results For : COLIN CROWLEY

Location :

Sample ID :

| | |
|---------------------------------------|-----------|
| pH | 7.8 |
| Total Dissolved Solids (TDS) Est, ppm | 378 |
| Electrical Conductivity, mmho/cm | 0.83 |
| Cations / Anions, meq/L | 7.0 / 6.4 |

| | ppm |
|-------------------------------------|------------|
| Sodium, Na | 9 |
| Potassium, K | 1 |
| Calcium, Ca | 69.6 |
| Magnesium, Mg | 37 |
| Total Hardness, CaCO ₃ | 329 |
| Nitrate, NO ₃ -N | 1.7 (SAFE) |
| Sulfate, SO ₄ -S | 4 |
| Chloride, Cl | 15 |
| Carbonate, CO ₃ | < 1.0 |
| Bicarbonate, HCO ₃ | 344 |
| Total Alkalinity, CaCO ₃ | 283 |
| Fluoride, F | 0.68 |
| Total Phosphorus, P | < 0.01 |
| Total Iron, Fe | < 0.01 |

*< - Not Detected / Below Detection Limit

Reviewed By : Nick Ward

5/19/2020

Copy : 1

Page 1 of 1

Bus: 308-234-2418

web site

4007 Cherry Ave., P.O. Box 788

Fax: 308-234-1940

www.wardlab.com

Kearney, Nebraska 68848-0788

MASH PH RECOMMENDATIONS

| | Recommended pH |
|----------------------|----------------|
| Lighter Colored | 5.3-5.4 |
| Darker Colored | 5.4-5.6 |
| Tart or Crisp Styles | 5.2-5.3 |

RECIPES LIGHT VS DARK

| IPA | Stout |
|-------------------------|---|
| 8 lbs Pale Malt (2 Row) | 4 lbs 12.53 oz Pale Malt (Maris Otter) (69%) |
| 10.31 oz Crystal 40 L | 8.50 oz Biscuit Malt |
| | 8.50 oz Chocolate Malt |
| | 8.50 oz Roasted Barley |
| | 8 oz Lactose |
| 4.82 gallons water | 4.65 gallons water |
| OG: 1.070 | OG: 1.058 |

MASH PH - LIGHT VS DARK

| | IPA | Stout |
|------------------------|---------|---------|
| Recommended Mash pH | 5.3-5.4 | 5.4-5.6 |
| Mash with RO | 5.68 | 5.44 |
| Mash with Madison Hard | 6.12 | 5.96 |
| Mash with Madison Soft | 6.26 | 6.13 |



HOW DO WE LOWER OUR MASH PH

- ACID REST – 2-3 HRS @ 94 F = CONVERTS PHYTIN WITH PHYTASE
- SOUR MASH – 24 HRS @ RT = LACTIC ACID BACTERIA PRODUCES LACTIC ACID
- USE SPECIALTY MALTS - DARK MALTS/ACIDULATED MALT = HIGH PHOSPHATE/LACTIC ACID
- DILUTE WITH RO = DECREASE ALKALINITY
- PRE-BOIL = PRECIPITATE OUT BICARBONATE (REDUCES 364 PPM BICARBONATE TO 164 PPM)
- SLAKED LIME = PRECIPITATE OUT BICARBONATE
- ADDING MINERALS = INTRODUCE MORE CALCIUM TO COMBINE WITH BICARBONATE
- ADDING ACIDS = PHOSPHORIC, LACTIC, MALIC, CITRIC, OR TARTARIC
- FIVE STAR “5.2” = LIKELY PHOSPHATE BLEND TO HIT MASH PH – NOT FORMULATED FOR HIGH BICARBONATE LEVELS



HOW MUCH DO WE ADD?

- READ MARK G'S BREWING WITH WATER (NOT SUCH A DUMB NAME NOW, RIGHT BRIAN?)
- BRU'N WATER*
- BEERSMITH WATER
- PRO-MASH
- OTHER WEBSITES (<https://www.brewersfriend.com/water-chemistry/>)

BRU'N WATER – DEMO – WATER PROFILE

Bru'n Water

[Link to Bru'n Water website for updates and to donate](#)

Enter data into **Light Blue** cells, **Yellow** cells display calculated results, **Pink** cells contain selection boxes

Program Volume Setting

Gallons < Select

Water Report Input

Hover cursor over cells w/ red corner marks to display info:

Cations

Enter Ion Concentrations from Water Report
(mg/L or ppm)

Anions

| | | | |
|---|------|-------|--------------------------------|
| Calcium (Ca) | 70.0 | 364.0 | Bicarbonate (HCO_3) |
| Magnesium (Mg) | 41.0 | 0.0 | Carbonate (CO_3) |
| Sodium (Na) | 9.0 | 21.0 | Sulfate (SO_4) |
| | | 19.0 | Chloride (Cl) |
| Optional Inputs (not required, but may improve ion balance) | | 0.0 | Nitrate (NO_3) |
| Potassium (K) | 0.0 | 0.0 | Nitrite (NO_2) |
| Iron (Fe) | 0.0 | 0.0 | Fluoride (F) |

multiply lab result by 3 if lab reports as $\text{SO}_4\text{-S}$

multiply lab result by 4.43 if lab reports as $\text{NO}_3\text{-N}$

Calculated Alkalinity

Alkalinity (ppm as CaCO_3)

298

<-- This value is automatically entered on the Sparge Acidification sheet

BRU'N WATER – DEMO - GRAINS

| A | B | C | D | E | F | G | AA | AB | AC |
|-------------------------|--|---------------------------------------|---|-------------------------------------|-------------------------------------|---------------------------------------|----|----|----|
| Bru'n Water | Link to Bru'n Water website for updates and to donate | | | | | | | | |
| Grain Bill Input | Hover cursor over cells w/ red corner marks to display helpful information | | | | | | | | |
| 4 | Enter data into Light Blue cells, Yellow cells display calculated results, Pink cells contain selection boxes | | | | | | | | |
| 5 | Grains | Grain Type | Quantity (lb) | Quantity (oz) | Color (L) | Percentage of Grain Bill | | | |
| 6 | 2 Row Pale Malt | Base Malt | 9.0 | 0.0 | 3 | 100.0 | | | |
| 7 | Munich | Base Malt | 0.0 | 0.0 | 8 | 0.0 | | | |
| 8 | Crystal 40L | Crystal Malt | 0.0 | 0.0 | 40 | 0.0 | | | |
| 9 | Special B | Crystal Malt | 0.0 | 0.0 | 28 | 0.0 | | | |
| 10 | Carafa | Roast Malt | 0.0 | 0.0 | 400 | 0.0 | | | |
| 11 | Chocolate | Roast Malt | 0.0 | 0.0 | 300 | 0.0 | | | |
| 12 | | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 13 | | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 14 | | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 15 | | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 16 | Enter grain names above to help verify that all the grist is entered | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 17 | | Base Malt | 0.0 | 0.0 | 0 | 0.0 | | | |
| 18 | Total Grist Weight (lbs) | 9.0 | Est. Beer Color (EBC) | | 8.2 | | | | |
| 19 | Water to Grist Ratio (Qts/Lb) | 1.78 | Est. Beer Color (SRM) | | 4.2 | | | | |
| 20 | Malt Color Setting | Lovibond | | | | | | | |
| 21 | Water used for Mash | Adjusted Water | | | | | | | |
| 22 | | | | | | | | | |
| | 0. Instructions | 1. Water Report Input | 2. Sparge Acidification | 3. Grain Bill Input | 4. Water Adjustment | 5. Adjustment Summary | | | |

BRU'N WATER – DEMO – MINERAL ADDITIONS

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | B | | | | | |
|---|---|--|--|-----------------|--------------|---|----------------|---|--|--------|---------------------------------|--------------------|------|---------------------------------|---|------|---------------------------------|---|------|--|--|--|--|--|
| Dilution Water Profile | | | | | | | | Brew: 18 to 30 SRM Black: over 31SRM | | | | | | | | | | | | | | | | |
| RO Water | | 1 | 0 | 8 | 1 | 4 | 16 | | | | | | | | | | | | | | | | | |
| Percent Dilution Water | | 0 | oz/gal | 0 | pt/gal | <These conversions are provided for your convenience. | | | | | | | | | | | | | | | | | | |
| Diluted Water Profile | | | | | | | | 70 | 41 | 9 | 21 | 19 | 364 | | | | | | | | | | | |
| Target Finished Water Adjustment (ppm) | | -26 | -31 | -4 | 44 | 26 | -364 | | | | | | | | | | | | | | | | | |
| Actual Finished Water Adjustment (ppm) | | 218 | 0 | 0 | 295 | 169 | 0 | | | | | | | | | | | | | | | | | |
| Mashing Water Profile | | | | | | | | 288 | 41 | 9 | 216 | 188 | 364 | | | | | | | | | | | |
| Estimated Mash pH | | | | | | | | 5.52 | This pH value is NOT VALID until the grain information is properly entered for the beer on the Grain Bill Input sheet. | | | | | | | | | | | | | | | |
| Water Additions | | | | | | | | Total Water Additions | | | | Total Batch Volume | | | | | | | | | | | | |
| Minerals | | Addition (grams/gal) | Calcium (ppm) | Magnesium (ppm) | Sodium (ppm) | Sulfate (ppm) | Chloride (ppm) | Bicarbonate (ppm) | Mash | Sparge | Water Volume (gal) | | 4.65 | Water Volume (gal) | | 0.00 | Water Volume (gal) | | 4.65 | | | | | |
| Gypsum (CaSO ₄ ·2H ₂ O) | | 2.00 | 123.0 | | | 294.9 | | | | | Total Mineral Additions (grams) | | 9.3 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Calcium Chloride (CaCl ₂) | | 1.00 | 95.4 | | | | 168.8 | | | | Total Mineral Additions (grams) | | 4.7 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Epsom Salt (MgSO ₄ ·7H ₂ O) | | 0.00 | | 0.0 | | 0.0 | | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Magnesium Chloride (MgCl ₂ ·6H ₂ O) | | 0.00 | | 0.0 | | 0.0 | | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Canning Salt (NaCl) | | 0.00 | | | 0.0 | | 0.0 | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Baking Soda (NaHCO ₃) | | 0.00 | | | 0.0 | | 0.0 | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Chalk (CaCO ₃) | | 0.00 | 0.0 | | | | | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Pickling Lime (Ca(OH) ₂) | | 0.00 | 0.0 | | | | | | | | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | Total Mineral Additions (grams) | | 0.0 | | | | | |
| Acids | | Addition | | | | Sulfate (ppm) | Chloride (ppm) | Bicarbonate (ppm) | | | | | | | | | | | | | | | | |
| Mash | | (mL/gal) | Mash Acid Strength parameters are entered below. | | | | | | Total Acid Addition (ml) | | | | | | | | | | | | | | | |
| Lactic | | 0.00 | Strength | 88.0 | x | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Total Acid Addition (ml) | | | | | | | | | | | | | |
| Sparge | | Sparge Acid Strength parameters are entered on the Sparge Acidification sheet. | | | | | | Total Acid Addition (ml) | | | | | | | | | | | | | | | | |
| Total | | 0.00 | Strength | 88.0 | x | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Total Acid Addition (ml) | | | | | | | | | | | | | |
| <p>0. Instructions 1. Water Report Input 2. Sparge Acidification 3. Grain Bill Input 4. Water Adjustment 5. Adjustment Summary</p> | | | | | | | | | | | | | | | | | | | | | | | | |

BRU'N WATER – DEMO – FORMULA

| A | B | C | D | E | F | G | H | I | J | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | | | | | | |
|---------------------------------|---|--|--|--------------|---------------|----------------|----------------|---|-----------------|----|----|----|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Bru'n Water | | Link to Bru'n Water website for updates and to donate | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Water Adjustment Summary | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Yellow Dry | | Water source water salts and source water to display helpful information | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Calcium (ppm) | Magnesium (ppm) | Sodium (ppm) | Sulfate (ppm) | Chloride (ppm) | Fluoride (ppm) | | | | | | | | | | | | | | | | | | | |
| | | 70 | 41 | 9 | 21 | 19 | 364 | | | | | | | | | | | | | | | | | | | |
| | | 288 | 41 | 9 | 316 | 188 | 364 | | | | | | | | | | | | | | | | | | | |
| Existing Water Profile | | 40 to 150 | 0 to 30 | 0 to 150 | 0 to 350 | 0 to 100 | as needed | | | | | | | | | | | | | | | | | | | |
| Mashing Water Profile | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Recommended Ranges | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mash Parameters | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Batch Volume (gallons) | 4.7 | Hardness (ppm or CaCO ₃) | 890 | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Estimated Mash pH | 5.52 | Alkalinity (ppm or CaCO ₃) | 298 | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Total Mash Water Vol (gal) 4.7 Total Sparge Water Vol (gal) 0.0 Total Volume = Top Volume + Dilution Volume | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Mash Dilution Vol (gal) 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Additions | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Mash Water Additions | | | | | | | | | | | | Sparge Water Additions | | | | | | | | | | | | | |
| 16 | Minerals | | (grams) | | | | | | (grams) | | | | | | | | | | | | | | | | | |
| 17 | Gypsum (CaSO ₄ x 2H ₂ O) | | 9.3 | | | | | | 0.0 | | | | | | | | | | | | | | | | | |
| 18 | Calcium Chloride (CaCl ₂) | | 4.7 | | | | | | 0.0 | | | | | | | | | | | | | | | | | |
| 19 | Epsom Salt (MgSO ₄ x 7H ₂ O) | | 0.0 | | | | | | 0.0 | | | | | | | | | | | | | | | | | |
| 20 | Magnesium Chloride (MgCl ₂) | | 0.0 | | | | | | 0.0 | | | | | | | | | | | | | | | | | |
| 21 | Canning Salt (NaCl) | | 0.0 | | | | | | 0.0 | | | | | | | | | | | | | | | | | |
| 22 | Baking Soda (NaHCO ₃) | | 0.0 | | | | | | Not Recommended | | | | | | | | | | | | | | | | | |
| 23 | Chalk (CaCO ₃) | | 0.0 | | | | | | Not Recommended | | | | | | | | | | | | | | | | | |
| 24 | Pickling Lime (Ca(OH) ₂) | | 0.0 | | | | | | Not Recommended | | | | | | | | | | | | | | | | | |
| 25 | Acids | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | Lactic | | 0.0 (ml) | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | Lactic | | 0.0 (ml) | | | | | | 0.0 (ml) | | | | | | | | | | | | | | | | | |
| 28 | 0. Instructions 1. Water Report Input 2. Sparge Acidification 3. Grain Bill Input 4. Water Adjustment 5. Adjustment Summary | | | | | | | | | | | | | | | | | | | | | | | | | |

BEERSMITH 2 – WATER PROFILE NOTE

YOU MUST SET YOUR MINERAL ADDS IN THE WATER PROFILE TOOL TO GET PROPER MASH PH

Water Profile Tool
Calculates water additions to match a given water profile

Water Profile (Parts Per Million)

| | Ions | Ca | Mg | Na | SO4 | Cl | HCO3 | |
|----------------|-------------------|--------------------------------|---------|---------|----------|---------|---------|-------|
| | Recommended Range | (50-150) | (10-40) | (0-150) | (50-250) | (0-250) | (0-250) | |
| Base Profile | 1.00 gal | Name: Glacier Water | 1.0 | 0.0 | 8.0 | 1.0 | 4.0 | 16.0 |
| | | Gypsum (CaSO4) | 1.5 g | 92.3 | | 221.1 | | |
| | | Table Salt (NaCl) | 0.0 g | | 0.0 | | 0.0 | |
| | | Epsom Salt (MgSO4) | 0.0 g | | 0.0 | | 0.0 | |
| | | Calcium Chloride (CaCl) | 1.5 g | 108.0 | | 191.1 | | |
| | | Baking Soda (NaHCO3) | 0.0 g | | 0.0 | | 0.0 | |
| | | Chalk (CaCO3) | 0.0 g | 0.0 | | | 0.0 | |
| Dilute With | 0.00 gal | Name: Sun Prairie Hard | 70.0 | 41.0 | 9.0 | 21.0 | 19.0 | 364.0 |
| Save Totals | | Totals | 201.3 | 0.0 | 8.0 | 222.1 | 195.1 | 16.0 |
| Target Profile | | Name: Bru'N Water - American L | 13.0 | 6.0 | 8.0 | 37.0 | 13.0 | 20.0 |
| | | Difference | 188.3 | -6.0 | 0.0 | 185.1 | 182.1 | -4.0 |

Match Target Profile

Analysis of 'Total' Water Profile Line

BEERSMITH 2- MASH TAB

IN ADDITION TO EST MASH PH, WILL CALCULATE AMOUNT OF ACID TO ADD BASED ON MEASURED PH – TRY ADDING 1/2 BEFORE MASH

My Recipes **Blank** X Program Leader Inventory Refractometer Grain Water Water Profile

Design Starter **Mash** Timer Session Vols Notes Save As Ok Cancel

Blank

Sparge If steeping, remove grains, and prepare to boil wort

Add Mash Step Edit Step Delete ▲ Move Step Up ▾ Move Step Down

50 F 25 F

30 min 60 min 90 min

Mash Initial Conditions

| | | | |
|----------------------|----------|--------------------|----------|
| Grain Temp | 72.0 F | Mash Tun Addition | 0.00 gal |
| Mash Tun Temperature | 72.0 F | Tun Deadspace | 0.00 gal |
| Decoction Boil Temp | 212.0 F | Mash Volume Needed | 7.42 gal |
| Mash Grain Wt | 8.64 lb | Mash Tun Volume | 3.96 gal |
| Grain Absorption | 0.63 gal | | |

Mash Volume Needed

Sparge/Lauter

| | |
|-------------------|----------|
| Sparge Vol | 0.00 gal |
| Sparge Temp | 168.1 F |
| Post Mash Gravity | 1.038 SG |
| Est Mash Eff | 73.8 % |
| Est Pre-Boil Vol | 6.11 gal |

Estimated Mash pH

| | | | |
|-----------------|----------------------------------|----------------------|--------------------|
| Water | Test1 | Measured Mash pH | |
| Water pH | 7.00 | Target pH | 5.60 |
| Water Resid Alk | -130.64 ppm as CaCO ₃ | Acid | Lactic Acid |
| Est Mash pH | 5.32 | Acid Concentration | 88.00 % |
| | | Mash Acid Amount | 9.3 ml |
| | | Sparge/Mash Out Acid | -0.0 ml (optional) |

BEERSMITH 3— WATER PROFILE NOTE

SET YOUR MINERAL PROFILE FIRST

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start Design Starter Water Mash Timer Session Notes Vols Save As Ok Cancel

Water Profile

Total Volume L For best results, add enough water to match this total volume.

| Am... | Name | Calcium | Magnesium | Sodium | Sulfate | Chloride | Bicarbonate |
|--------|------------------|-----------|-----------|----------|-----------|-----------|-------------|
| 0.00 L | Sun Prairie Hard | 70.00 ppm | 41.00 ppm | 9.00 ppm | 21.00 ppm | 19.00 ppm | 364.00 ppm |
| 3.79 L | Glacier Water | 1.00 ppm | 0.00 ppm | 8.00 ppm | 1.00 ppm | 4.00 ppm | 16.00 ppm |

Water Ingred Vol L Base Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Water Adjustment Salts

| Am... | Name | Use | Calci... | Magnesi... | Sodium | Sulfate | Chloride | Bicarbon... |
|-------|------|-----|----------|------------|--------|---------|----------|-------------|
|-------|------|-----|----------|------------|--------|---------|----------|-------------|

Don't Include Water Salts Hold Sparge Salts Until Boil Water Profile Matched

Adjusted Water Profiles

Tot Mash Water L Adjusted Profiles are based on mash and sparge volumes shown

Calcium ppm (50-150) • Sodium ppm (0-150) • Chloride ppm (0-250) •
Magnesium ppm (10-40) • Sulfate ppm (50-250) • Bicarbonate ppm (0-250) •

Sparge Vol L • Adj Sparge Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Water Analysis

Alkalinity ppm Water Resid Alk ppm as CaCO₃ Sulfate to Chloride Ratio
Effective Hardness ppm Water Color Range 6-11 SRM Sulfate/Chloride Balance Extremely Malty

BEERSMITH 3— WATER PROFILE NOTE

DETERMINE YOUR FINAL PROFILE

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start

Water Profile

Total Volume 22.00

Am... Name
0.00 L Sun Prairie
3.79 L Glacier Wat

Water Ingred Vol

Water Adjustment Salts

Am... Name

Water Profile

Base Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Target Profile to Match

Choose Target Profile Water Profile Matched Br'N Water - American Lager

Calcium 13.0 ppm (50-150) Sulfate 37.0 ppm (50-250)
Magnesium 6.0 ppm (10-40) Chloride 13.0 ppm (0-250)
Sodium 8.0 ppm (0-150) Bicarbonate 20.0 ppm (0-250)

Water Salts for Best Fit of Water Profile

Exclude Chalk
Best Mash Additions Gypsum: 0.0 g, Salt: 0.0 g, Epsom Salt: 0.0 g, Calcium Chloride: 0.0 g, Baking Soda: 0.0 g, Chalk: 0.0 g
Best Sparge Additions Gypsum: 0.4 g, Salt: 0.0 g, Epsom Salt: 1.4 g, Calcium Chloride: 0.4 g, Baking Soda: 0.0 g, Chalk: 0.1 g
If you click 'Ok' the water agents in your recipe will be adjusted to match these

Adjusted Water Profile

Don't Include Water Salts
Profile with additions Calcium: 13.1 ppm, Magnesium: 6.2 ppm, Sodium: 8.2 ppm, Sulfate: 37.0 ppm, Chloride: 12.9 ppm, Bicarbonate: 19.9 ppm

Adjusted Water Profile

Tot Mash Water 0

Help Ok Cancel

Calcium 1.0 ppm (50-150) Sodium 8.0 ppm (0-150) Chloride 4.0 ppm (0-250)
Magnesium 0.0 ppm (10-40) Sulfate 1.0 ppm (50-250) Bicarbonate 16.0 ppm (0-250)

Sparge Vol 21.56 L Adj Sparge Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Water Analysis

Alkalinity 13.1 ppm Water Resid Alk 12.40 ppm as CaCO₃ Sulfate to Chloride Ratio 0.3
Effective Hardness 0.7 ppm Water Color Range 5-11 SRM Sulfate/Chloride Balanc Quicken Deluxe - qdatacurrent20181202 - [Home]

9:30 PM

BEERSMITH 3— WATER PROFILE NOTE

DETERMINE YOUR FINAL PROFILE

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start

Water Profile

Total Volume 22.00

Am... Name
0.00 L Sun Prairie
3.79 L Glacier Wat

Water Ingred Vol

Water Adjustment Salts

Am... Name

Water Profile

Base Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Target Profile to Match

Choose Target Profile Water Profile Matched Br'N Water - American Lager

Calcium 13.0 ppm (50-150) Sulfate 37.0 ppm (50-250)
Magnesium 6.0 ppm (10-40) Chloride 13.0 ppm (0-250)
Sodium 8.0 ppm (0-150) Bicarbonate 20.0 ppm (0-250)

Water Salts for Best Fit of Water Profile

Exclude Chalk
Best Mash Additions Gypsum: 0.0 g, Salt: 0.0 g, Epsom Salt: 0.0 g, Calcium Chloride: 0.0 g, Baking Soda: 0.0 g, Chalk: 0.0 g
Best Sparge Additions Gypsum: 0.4 g, Salt: 0.0 g, Epsom Salt: 1.4 g, Calcium Chloride: 0.4 g, Baking Soda: 0.0 g, Chalk: 0.1 g
If you click 'Ok' the water agents in your recipe will be adjusted to match these

Adjusted Water Profile

Don't Include Water Salts
Profile with additions Calcium: 13.1 ppm, Magnesium: 6.2 ppm, Sodium: 8.2 ppm, Sulfate: 37.0 ppm, Chloride: 12.9 ppm, Bicarbonate: 19.9 ppm

Adjusted Water Profile

Tot Mash Water 0

Help Ok Cancel

Calcium 1.0 ppm (50-150) Sodium 8.0 ppm (0-150) Chloride 4.0 ppm (0-250)
Magnesium 0.0 ppm (10-40) Sulfate 1.0 ppm (50-250) Bicarbonate 16.0 ppm (0-250)

Sparge Vol 21.56 L Adj Sparge Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Water Analysis

Alkalinity 13.1 ppm Water Resid Alk 12.40 ppm as CaCO₃ Sulfate to Chloride Ratio 0.3
Effective Hardness 0.7 ppm Water Color Range 5-11 SRM Sulfate/Chloride Balanc Quicken Deluxe - qdatacurrent20181202 - [Home]

9:30 PM

BEERSMITH 3— WATER PROFILE NOTE

BEERSMITH WILL CALCULATE YOUR INGREDIENT ADDS

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start Design Starter Water Mash Timer Session Notes Vols Save As Ok Cancel

Water Profile

Total Volume 22.00 L For best results, add enough water to match this total volume.

| Am... | Name | Calcium | Magnesium | Sodium | Sulfate | Chloride | Bicarbonate |
|--------|------------------|-----------|-----------|----------|-----------|-----------|-------------|
| 0.00 L | Sun Prairie Hard | 70.00 ppm | 41.00 ppm | 9.00 ppm | 21.00 ppm | 19.00 ppm | 364.00 ppm |
| 3.79 L | Glacier Water | 1.00 ppm | 0.00 ppm | 8.00 ppm | 1.00 ppm | 4.00 ppm | 16.00 ppm |

Water Ingrd Vol 3.79 L Base Water Profile Calcium: 1.0 ppm, Magnesium: 0.0 ppm, Sodium: 8.0 ppm, Sulfate: 1.0 ppm, Chloride: 4.0 ppm, Bicarbonate: 16.0 ppm

Water Adjustment Salts

| Am... | Name | Use | Calci... | Magnesi... | Sodium | Sulfate | Chloride | Bicarbon... |
|--------|--------------------------|--------|----------|------------|---------|----------|----------|-------------|
| 0.12 g | Chalk | Sparge | 2.3 ppm | 0.0 ppm | 0.0 ppm | 0.0 ppm | 0.0 ppm | 3.4 ppm |
| 0.40 g | Calcium Chloride | Sparge | 5.0 ppm | 0.0 ppm | 0.0 ppm | 0.0 ppm | 8.9 ppm | 0.0 ppm |
| 0.45 g | Gypsum (Calcium Sulfate) | Sparge | 4.8 ppm | 0.0 ppm | 0.0 ppm | 11.5 ppm | 0.0 ppm | 0.0 ppm |
| 1.35 g | Epsom Salt (MgSO4) | Sparge | 0.0 ppm | 6.2 ppm | 0.0 ppm | 24.4 ppm | 0.0 ppm | 0.0 ppm |

Don't Include Water Salts Hold Sparge Salts Until Boil Water Profile Matched Bru'N Water - American Lager

Adjusted Water Profiles

Tot Mash Water 0.44 L Adjusted Profiles are based on mash and sparge volumes shown

Calcium 1.0 ppm (50-150) • Sodium 8.0 ppm (0-150) • Chloride 4.0 ppm (0-250) •
Magnesium 0.0 ppm (10-40) • Sulfate 1.0 ppm (50-250) • Bicarbonate 16.0 ppm (0-250) •

Sparge Vol 21.56 L Adj Sparge Water Profile Calcium: 13.1 ppm, Magnesium: 6.2 ppm, Sodium: 8.0 ppm, Sulfate: 37.0 ppm, Chloride: 12.9 ppm, Bicarbonate: 19.4 ppm

Water Analysis

Alkalinity 13.1 ppm Water Resid Alk 12.40 ppm as CaCO₃ Sulfate to Chloride Ratio 0.3

Effective Hardness 0.7 ppm Water Color Range 6-11 SRM Sulfate/Chloride Balan Quicken Deluxe - qdatacurrent20181202 - [Home]

BEERSMITH 3— WATER PROFILE NOTE

MASH TAB WILL GIVE YOU ESTIMATED PH

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start Design Starter Water Mash Timer Session Notes Vols Save As Ok Cancel

Mash Profile

Mash Single Infusion, Full Body, Batch Sparging
 Adjust Temp for Equip

| Name | Description | Step ... | Step ... |
|------------|--------------------------------|----------|----------|
| Mash In | Add 0.44 L of water at 170.5 F | 158.0 F | 60 min |
| Mash St... | Heat to 168.0 F over 10 min | 168.0 F | 5 min |

Sparge Batch sparge with 2 steps (10.64L, 10.92L) of 170.0 F water

Add Mash Step Edit Step Delete Move Step Up Move Step Down

Mash Initial Conditions

| | | | | | | | |
|----------------------|---------|---|---------|-------------------|----------|--------------------|--------------------------------|
| Grain Temp | 72.0 F | Mash Tun Addition | 0.00 L | Sparge Vol | 21.56 L | Water | Mixed Profiles |
| Mash Tun Temperature | 72.0 F | Tun Deadspace | 0.00 L | Sparge Temp | 170.0 F | Water pH | 7.00 |
| Decoction Boil Temp | 212.0 F | <input checked="" type="checkbox"/> Adjust Mash Vol for Deadspace | | Post Mash Gravity | 1.000 SG | Water Resid Alk | 12.40 ppm as CaCO ₃ |
| Mash Grain Wt | 0.17 kg | Mash Volume Needed | 0.55 L | Est Mash Eff | 0.0 % | Unadjusted Mash pH | 5.74 |
| Grain Absorption | 0.17 L | Mash Tun Volume | 30.00 L | Est Pre-Boil Vol | 21.83 L | | |

Mash pH Acid Additions

| Amt | Name |
|-----|------|
|-----|------|

Final Mash pH Adjustments

| | |
|--------------------|-------------------|
| Adjusted Mash pH | 5.74 |
| Measured Mash pH | 0.00 |
| Target pH | 5.40 |
| Acid | Lactic Acid |
| Acid Concentration | 88.00 % |
| Mash Acid Amount | 0.0 ml (0.0 tbsp) |

BEERSMITH 3— WATER PROFILE NOTE

CAN CALCULATE AMOUNT TO INCLUDE IN MASH TO HIT DESIRED PH

My Recipes >... Cloud Beer Start 5 - Vodka Wa... 66 - Cherry ... Style Volume Units Weight Units

Beer Start Design Starter Water **Mash** Timer Session Notes Vols Save As Ok Cancel

Mash Single Infusion, Full Body, Batch Sparging Adjust Temp for Equip

| Name | Description | Step ... | Step ... |
|------------|--------------------------------|----------|----------|
| Mash In | Add 0.44 L of water at 170.5 F | 158.0 F | 60 min |
| Mash St... | Heat to 168.0 F over 10 min | 168.0 F | 5 min |

Sparge Batch sparge with 2 steps (10.64L, 10.92L) of 170.0 F water

Add Mash Step Edit Step Delete Move Step Up Move Step Down

Mash Initial Conditions

| | | | |
|----------------------|---------|---|---------|
| Grain Temp | 72.0 F | Mash Tun Addition | 0.00 L |
| Mash Tun Temperature | 72.0 F | Tun Deadspace | 0.00 L |
| Decoction Boil Temp | 212.0 F | <input checked="" type="checkbox"/> Adjust Mash Vol for Deadspace | |
| Mash Grain Wt | 0.17 kg | Mash Volume Needed | 0.55 L |
| Grain Absorption | 0.17 L | Mash Tun Volume | 30.00 L |

Mash Volume Needed

| | |
|-------------------|----------|
| Sparge Vol | 21.56 L |
| Sparge Temp | 170.0 F |
| Post Mash Gravity | 1.000 SG |
| Est Mash Eff | 0.0 % |
| Est Pre-Boil Vol | 21.83 L |

Sparge/Lauter

| | |
|--------------------|--------------------------------|
| Water | Mixed Profiles |
| Water pH | 7.00 |
| Water Resid Alk | 12.40 ppm as CaCO ₃ |
| Unadjusted Mash pH | 5.74 |

Water and Unadjusted Mash pH

Mash pH Acid Additions

| | |
|---------|--------------------|
| Amt | Name |
| 0.20 ml | Lactic Acid (Mash) |

Final Mash pH Adjustments

| | | |
|---|----------------------|------------------------------|
| <input checked="" type="checkbox"/> Add Acid | Adjusted Mash pH | 5.35 |
| <input checked="" type="checkbox"/> Add Acid Malt | Measured Mash pH | 0.00 |
| <input checked="" type="checkbox"/> Edit | Target pH | 5.40 |
| <input checked="" type="checkbox"/> Delete | Acid | Lactic Acid |
| | Acid Concentration | 88.00 % |
| | Mash Acid Amount | 0.0 ml (0.0 tbsp) |
| | Sparge/Mash Out Acid | 0.0 ml (0.0 tbsp) (optional) |

RECIPES – WITH MINERAL ADDITION

| IPA | Stout |
|-------------------------|--|
| 8 lbs Pale Malt (2 Row) | 4 lbs 12.53 oz Pale Malt (Maris Otter) |
| 10.31 oz Crystal 40 L | 8.50 oz Biscuit Malt |
| 7.3 g gypsum | 8.50 oz Chocolate Malt |
| 7.3 g Calcium Chloride | 8.50 oz Roasted Barley |
| 4.82 gallons RO | 4.65 gallons RO |
| Mash pH 5.32 | Mash pH 5.44 |



PART II: PUTTING IT ALL TOGETHER

- FORMULATION
 - WATER – MASH VS. SPARGE
 - MINERALS
 - MASH PH
 - FLAVOR IMPACT IN FINAL BEER
- PREPARATION/BREW DAY



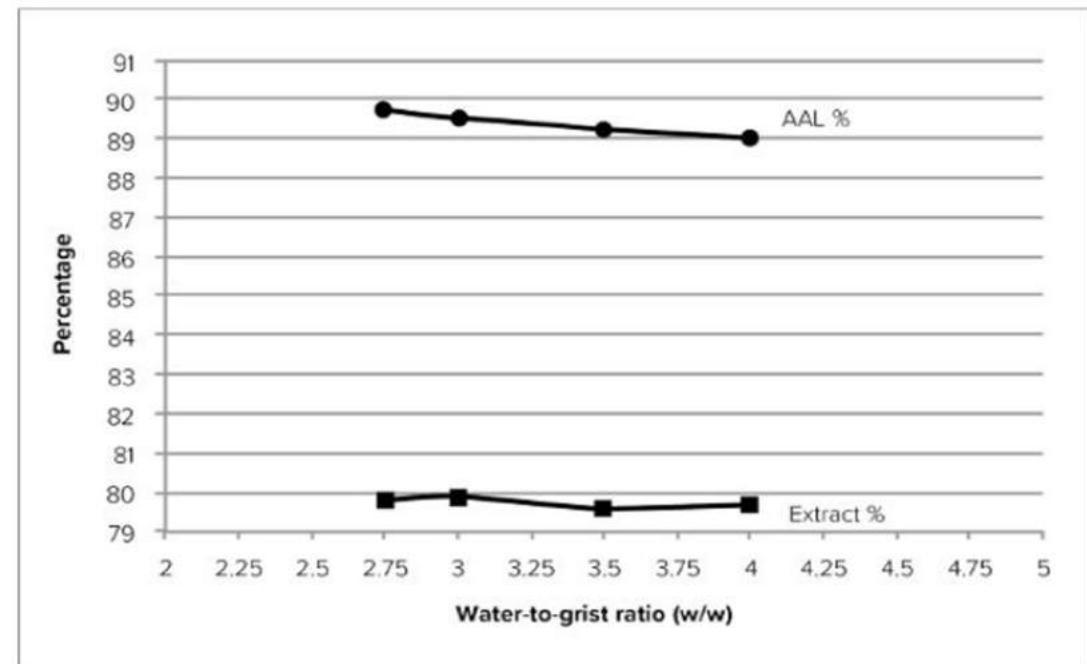
GEAR

| | |
|--|------|
| Dr.meter 0.01 Resolution High Accuracy Pocket Size pH Meter with ATC | \$37 |
| AWS Series Digital Pocket Weight Scale | \$15 |
| 88% Lactic Acid | \$ 7 |
| BAXA ExactaMed Oral Liquid Medication Syringe | \$ 6 |
| Sodium Hydroxide 4 oz. | \$ 8 |
| TDS Meter | \$14 |
| Frienda 4 Pack Large Plastic Syringe for Scientific Labs | \$ 8 |

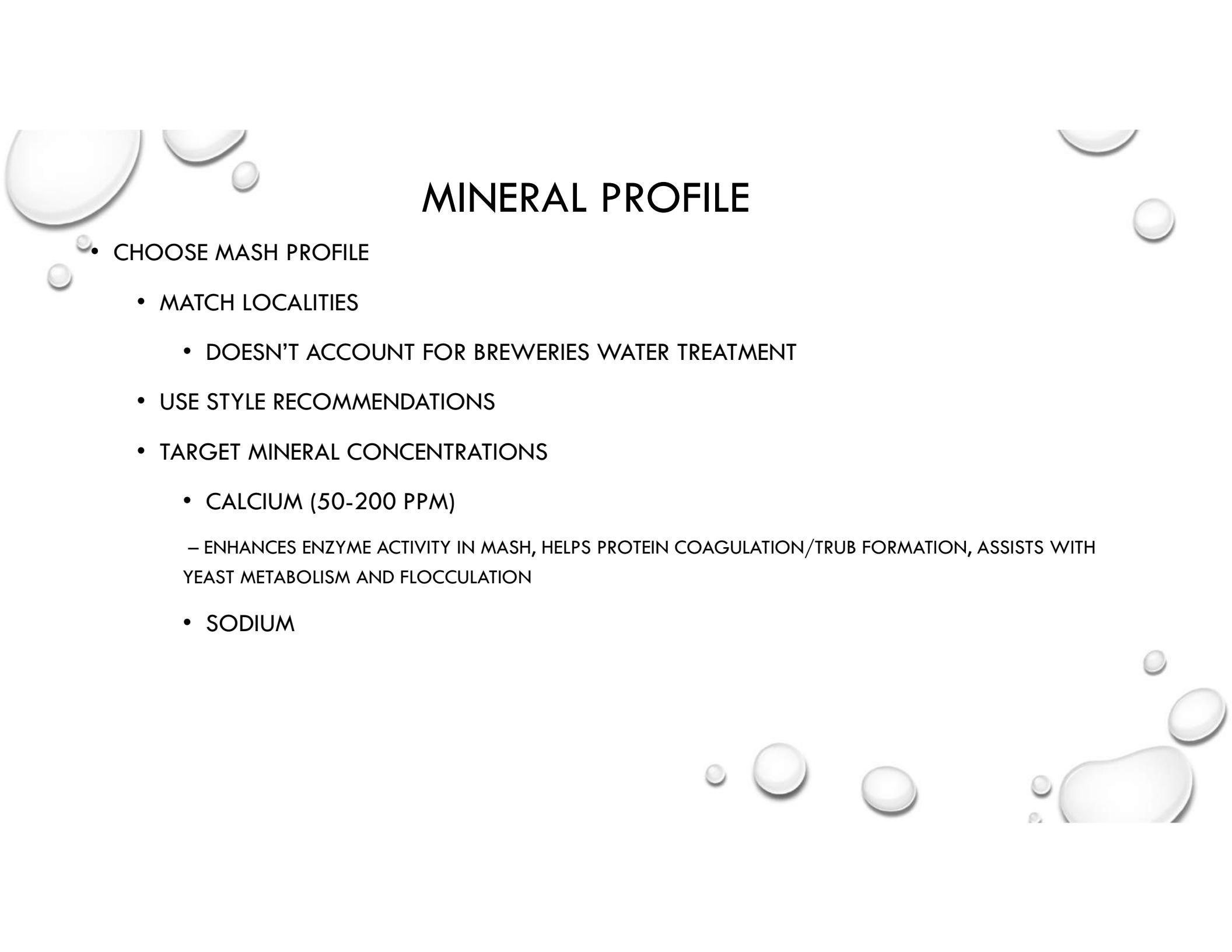


WATER ADDITIONS

- TOTAL WATER
 - CALCULATE BACKWARDS FROM BATCH VOLUME+PROCESS LOSSES+ABSORPTION
- WATER IN MASH
 - LOW WTG - LESS FERMENTABLE, SWEETER MASH
 - HIGH WTG – DILUTES ENZYMES, LONGER MASH
- SWEET SPOT
1.25 – 2.00 QT/LB
- SPARGE WATER



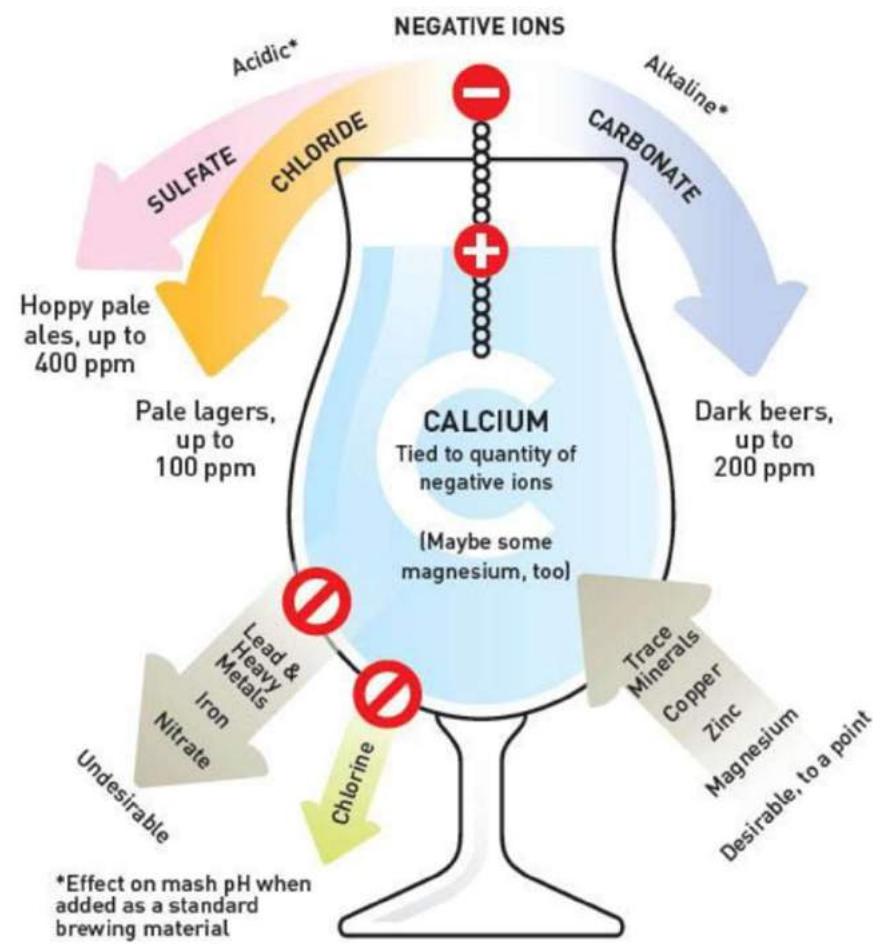
SPARGE WATER = TOTAL WATER-MASH WATER



MINERAL PROFILE

- CHOOSE MASH PROFILE
 - MATCH LOCALITIES
 - DOESN'T ACCOUNT FOR BREWERIES WATER TREATMENT
 - USE STYLE RECOMMENDATIONS
 - TARGET MINERAL CONCENTRATIONS
 - CALCIUM (50-200 PPM)
 - ENHANCES ENZYME ACTIVITY IN MASH, HELPS PROTEIN COAGULATION/TRUB FORMATION, ASSISTS WITH YEAST METABOLISM AND FLOCCULATION
 - SODIUM

MINERAL PROFILE



TARGET MINERAL CONCENTRATIONS

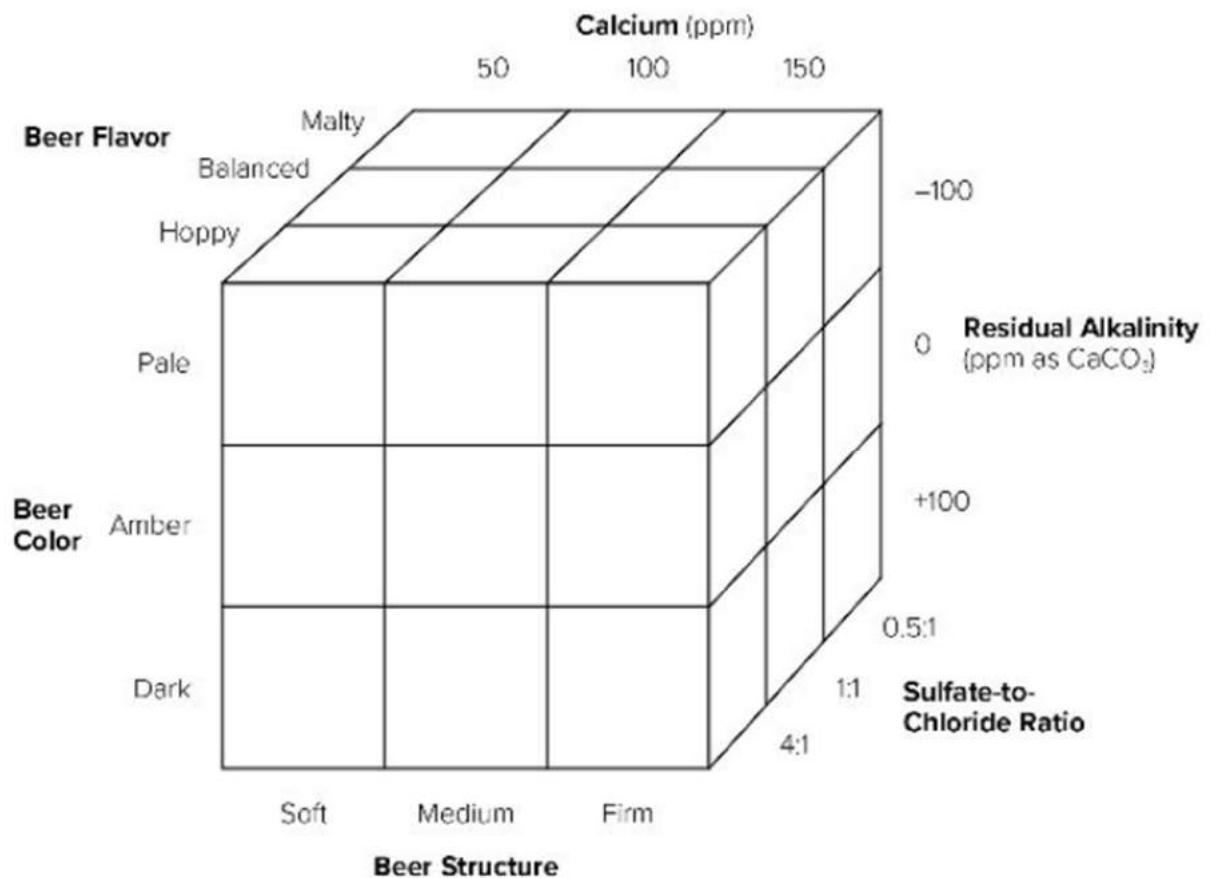
- CALCIUM (50-200 PPM)
 - ENHANCES ENZYME ACTIVITY IN MASH, HELPS PROTEIN COAGULATION/TRUB FORMATION, ASSISTS WITH YEAST METABOLISM AND FLOCCULATION
- MAGNESIUM (5-40 PPM)
- SODIUM (<100 PPM)
 - SWEETENS MALT CHARACTER, IMPROVES MOUTHFEEL AND FULLNESS IN PALE BEERS
- CHLORIDE (50-200 PPM)
 - ENHANCES ROUNDNESS, SWEETNESS, AND FULLNESS OF MALTS, CAN CORRODE METAL
- SULFATE (50-500 PPM)
 - ENHANCES ASSERTIVENESS AND DRYNESS OF HOPS
- SULFATE-CHLORIDE RATIO (0.5-9)
 - LOW RATIO IS MALTY, HIGH RATIO IS HOPPY

MASHING IN WATER

- CHECK PH
- TEMPERATURE CORRECT PH
 - ATC WILL CORRECT INSTRUMENTS TEMPERATURE DEPENDENT RESPONSE
 - DOES NOT ACCOUNT FOR PH SHIFT IN SOLUTION
 - $\text{PH} = \text{PH}_{\text{mash}} + 0.0055 * (\text{T} - \text{T}_{\text{room}})$ (C)
 - $\text{PH} = \text{PH}_{\text{mash}} + 0.00306 * (\text{T} - \text{T}_{\text{room}})$ (F)
- CORRECT PH AS NEEDED
 - LACTIC ACID
 - PHOSPHORIC ACID
 - CHALK/SODIUM BICARBONATE
 - SLAKED LIME/SODIUM HYDROXIDE
 - GYPSUM/CALCIUM CHLORIDE

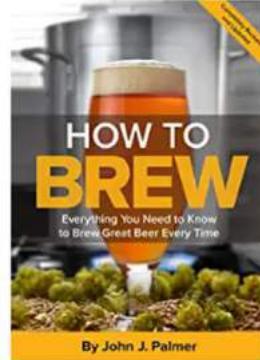
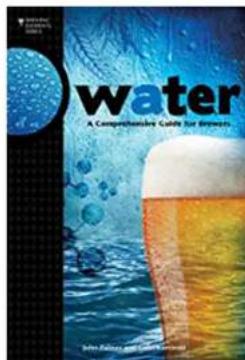
MINERAL ADDITION

- SLOW AND STEADY
- CAN ALWAYS ADD MORE
- BUT CAN'T TAKE OUT

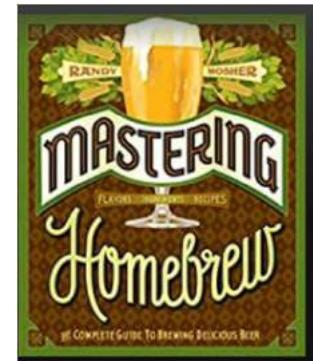


References

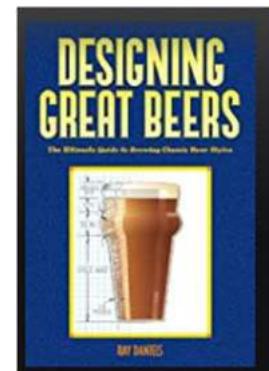
- BRU'N WATER (<https://www.brunwater.com/>)
- BRAUKAISER (<http://braukaiser.com/blog/?s=water&submit=Search>)
- EXPERIMENTAL HOMEBREWING (<https://www.experimentalbrew.com/podcast/brew-files-episode-86-water-primer>)
- BEERSMITH (<http://beersmith.com/>)
- JOHN PALMER

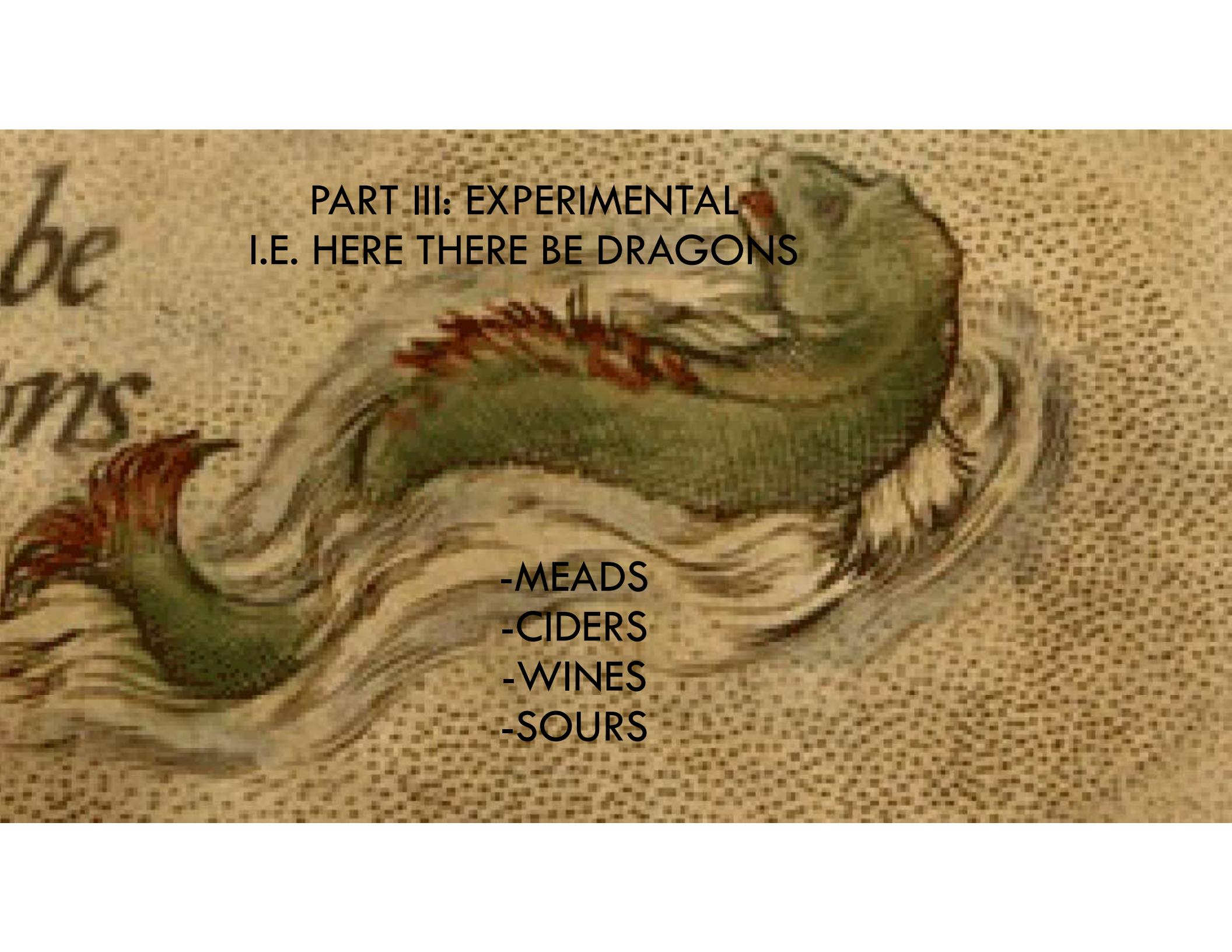


RANDY MOSHER



RAY DANIELS

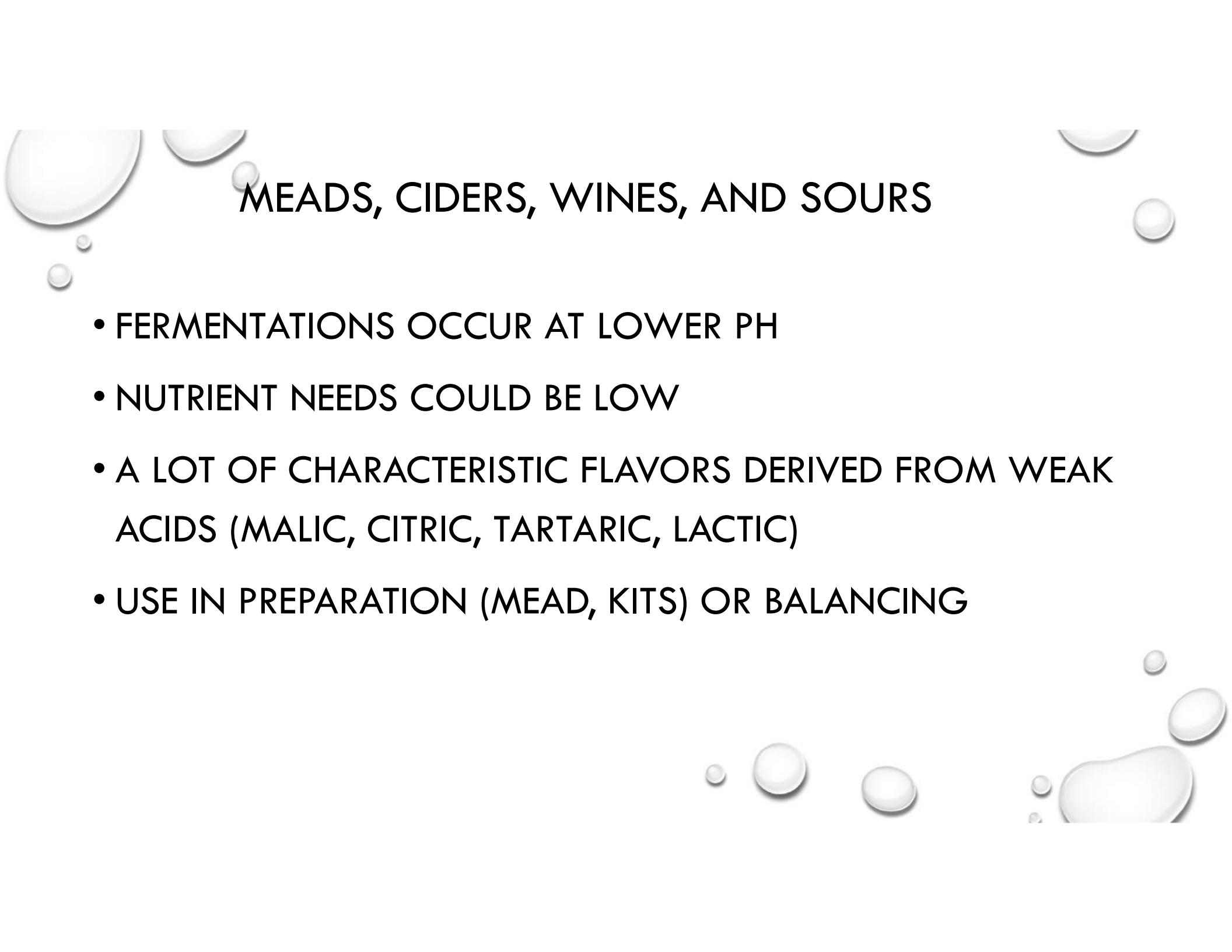




PART III: EXPERIMENTAL

I.E. HERE THERE BE DRAGONS

- MEADS
- CIDERS
- WINES
- SOURS

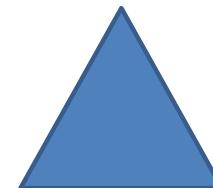
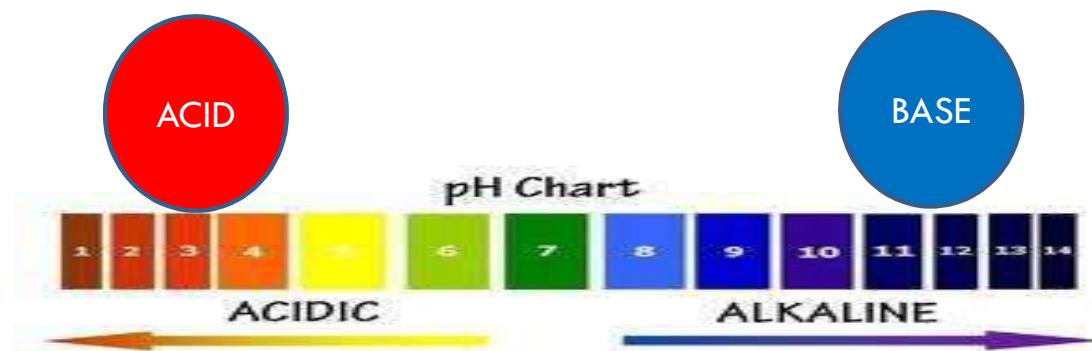


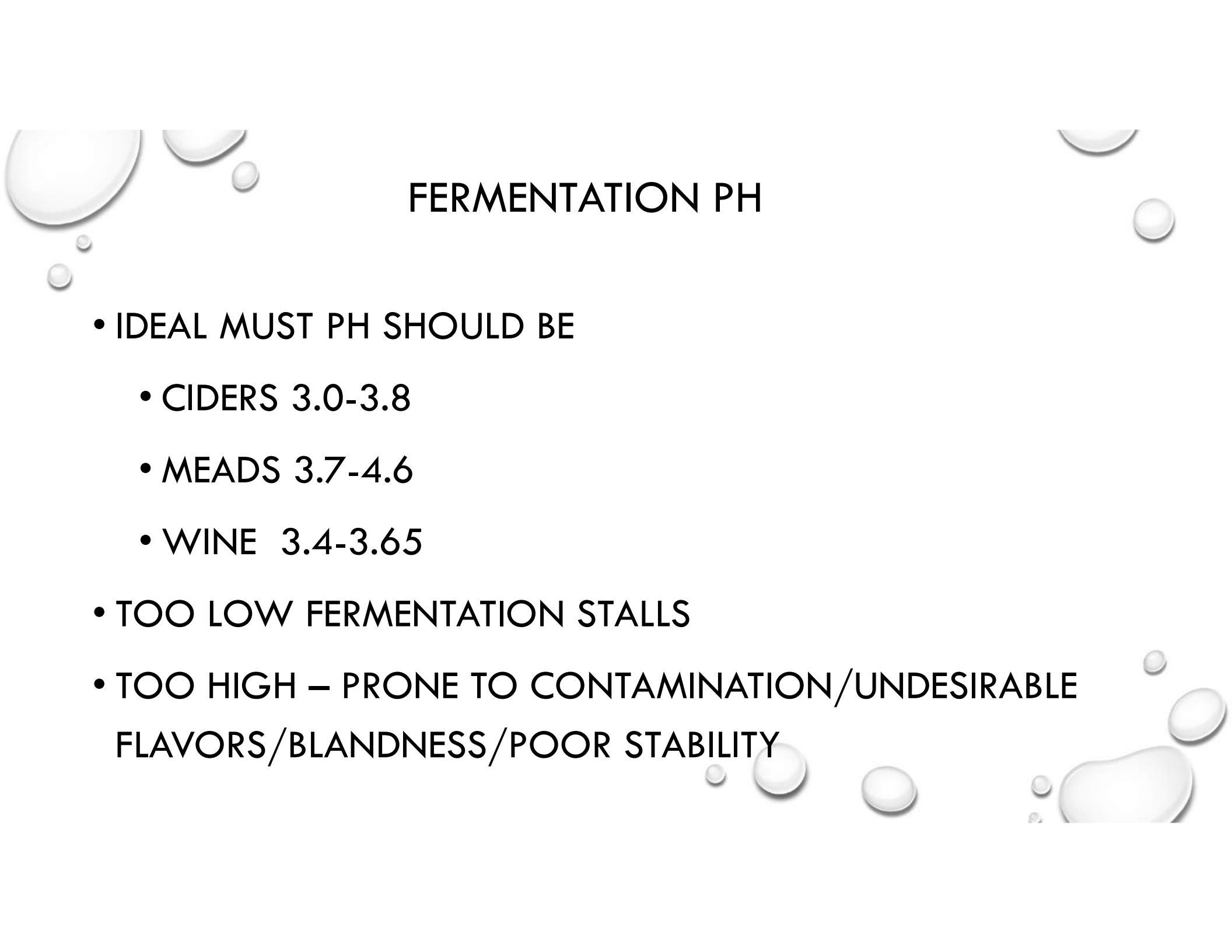
MEADS, CIDERS, WINES, AND SOURS

- FERMENTATIONS OCCUR AT LOWER PH
- NUTRIENT NEEDS COULD BE LOW
- A LOT OF CHARACTERISTIC FLAVORS DERIVED FROM WEAK ACIDS (MALIC, CITRIC, TARTARIC, LACTIC)
- USE IN PREPARATION (MEAD, KITS) OR BALANCING

REMINDER FROM PART I

- PH – MEASURE OF HOW ACIDIC (LOW PH) OR ALKALINE (HIGH PH) SOMETHING IS
- TOTAL ACIDITY/ALKALINITY – HOW MUCH RESISTANCE THERE IS TO CHANGE PH



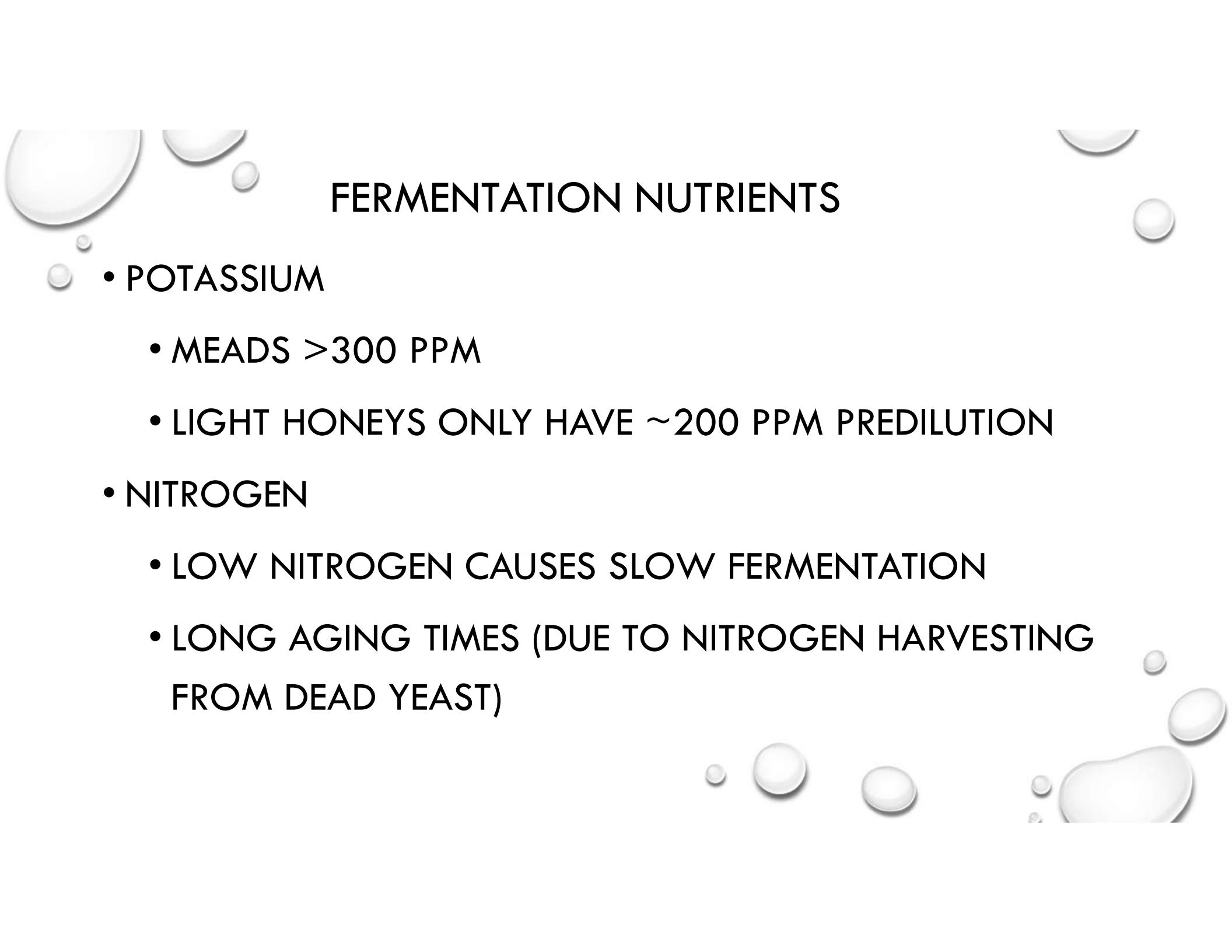


FERMENTATION PH

- IDEAL MUST PH SHOULD BE
 - CIDERS 3.0-3.8
 - MEADS 3.7-4.6
 - WINE 3.4-3.65
- TOO LOW FERMENTATION STALLS
- TOO HIGH – PRONE TO CONTAMINATION/UNDESIRABLE FLAVORS/BLANDNESS/POOR STABILITY

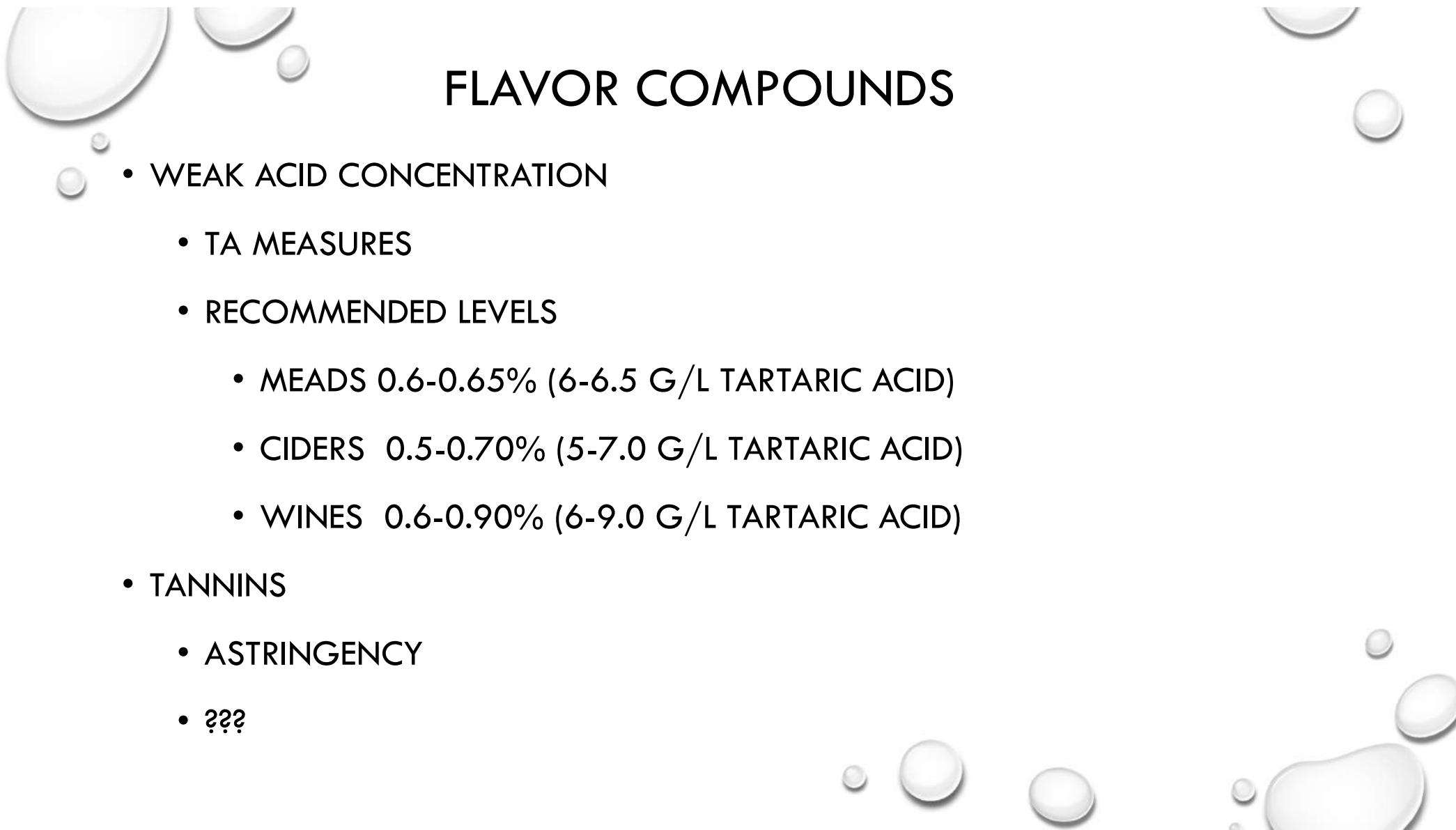
LOCAL WATER PROFILES

| | RO | Madison Hard | Madison Soft |
|-------------|----|--------------|--------------|
| Calcium | 1 | 70 | 3 |
| Magnesium | 0 | 41 | 2 |
| Sodium | 8 | 9 | 151 |
| Sulfate | 1 | 21 | 21 |
| Chloride | 4 | 19 | 19 |
| Bicarbonate | 16 | 364 | 364 |
| Alkalinity | 13 | 302 | 302 |
| Hardness | 3 | 259 | 12 |



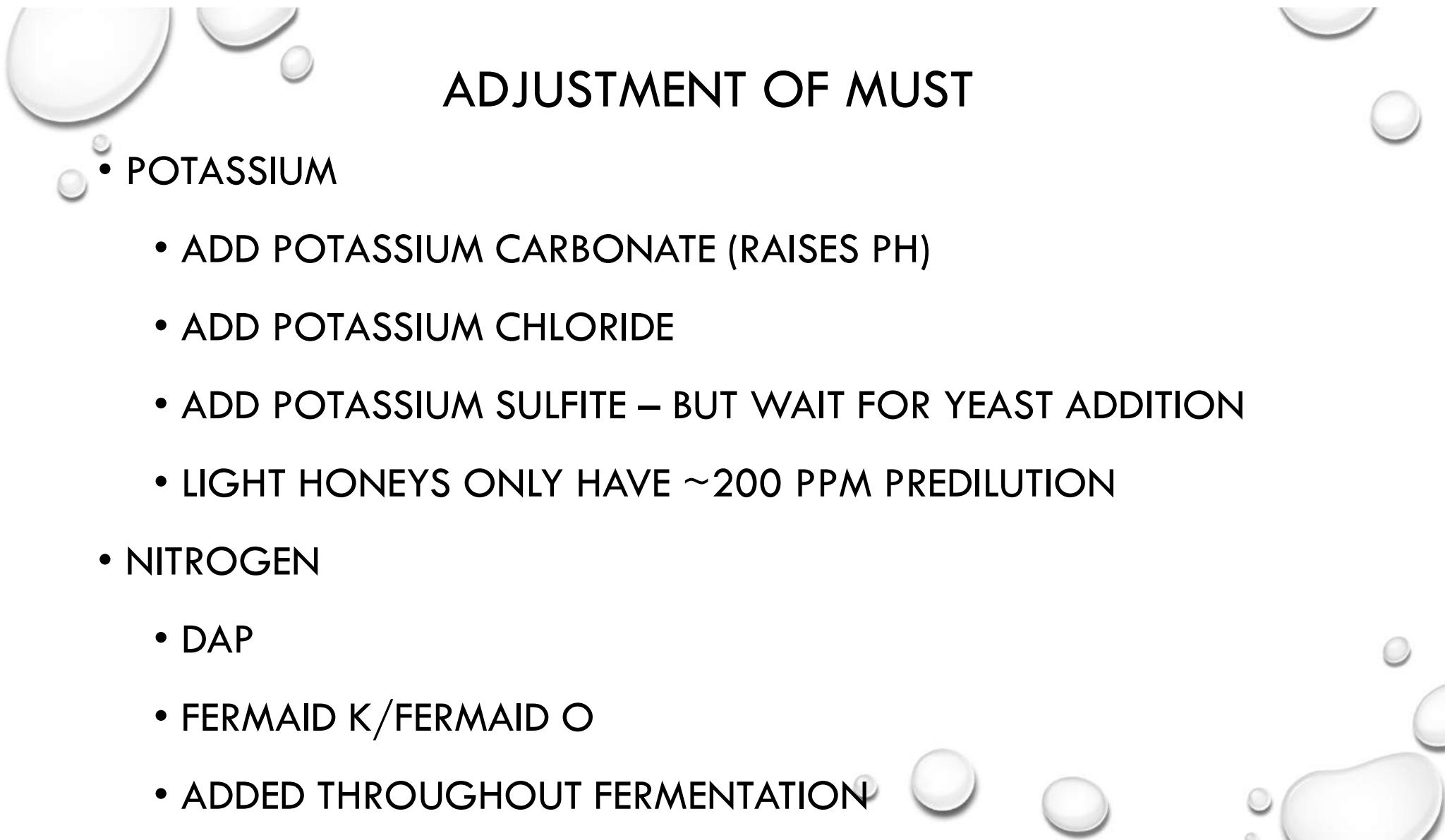
FERMENTATION NUTRIENTS

- POTASSIUM
 - MEADS >300 PPM
 - LIGHT HONEYS ONLY HAVE ~200 PPM PREDILUTION
- NITROGEN
 - LOW NITROGEN CAUSES SLOW FERMENTATION
 - LONG AGING TIMES (DUE TO NITROGEN HARVESTING FROM DEAD YEAST)



FLAVOR COMPOUNDS

- WEAK ACID CONCENTRATION
 - TA MEASURES
 - RECOMMENDED LEVELS
 - MEADS 0.6-0.65% (6-6.5 G/L TARTARIC ACID)
 - CIDERS 0.5-0.70% (5-7.0 G/L TARTARIC ACID)
 - WINES 0.6-0.90% (6-9.0 G/L TARTARIC ACID)
- TANNINS
 - ASTRINGENCY
 - ???



ADJUSTMENT OF MUST

- POTASSIUM

- ADD POTASSIUM CARBONATE (RAISES PH)
- ADD POTASSIUM CHLORIDE
- ADD POTASSIUM SULFITE – BUT WAIT FOR YEAST ADDITION
- LIGHT HONEYS ONLY HAVE ~200 PPM PREDILUTION

- NITROGEN

- DAP
- FERMAID K/FERMAID O
- ADDED THROUGHOUT FERMENTATION

ADJUSTMENT OF MUST

- ACIDS

- TOO LOW

- CITRIC ACID

- MALIC ACID

- TARTARIC ACID

- ACID BLEND

- TOO HIGH

- POTASSIUM CARBONATE

- POTASSIUM HYDROXIDE

- CALCIUM CARBONATE

- MALOLACTIC FERMENTATION

- TYPICALLY ADJUSTED BEFORE FERMENTATION

QUESTIONS?