bee to beer

National Honey Board™

Keith Seiz and Alison Wuebbels
National Honey Board

National Honey Board

- Based in Colorado.
- Industry-funded agriculture promotion group that works to educate consumers and food and beverage processors about the benefits and uses for honey
- Research, marketing, advertising and promotional programs
- Ingredient Marketing Program
- Craft beer focus

What's a honey beer?

Honey is more than a sugar source or brewery adjunct.

Honey bees are an amazing insect.

Earliest evidence of honey bees dates back over 100 millions years ago to Patagonia.

The recent find confirms that bees and some of the first flowering plants diversified in tandem around 110 to 120 million years ago, during the Early Cretaceous.

Honey bees are essential to our ecosystem.

More than 35% of the foods Americans consume come from honey bees.

Honey is a highly complex substance.

What's in honey? Carbohydrates, minerals, vitamins, prebiotics, acids, volatile organic compounds, bacteria, yeast.

However, it's very simply made, by bees, not machines.

Honey has thousands of varietals, all dependent on where the bee forage for nectar.

Honey plays unique and diverse roles in brewing.

Sweetness

Complexity

Elevation

Crushability

Bottle Conditioning

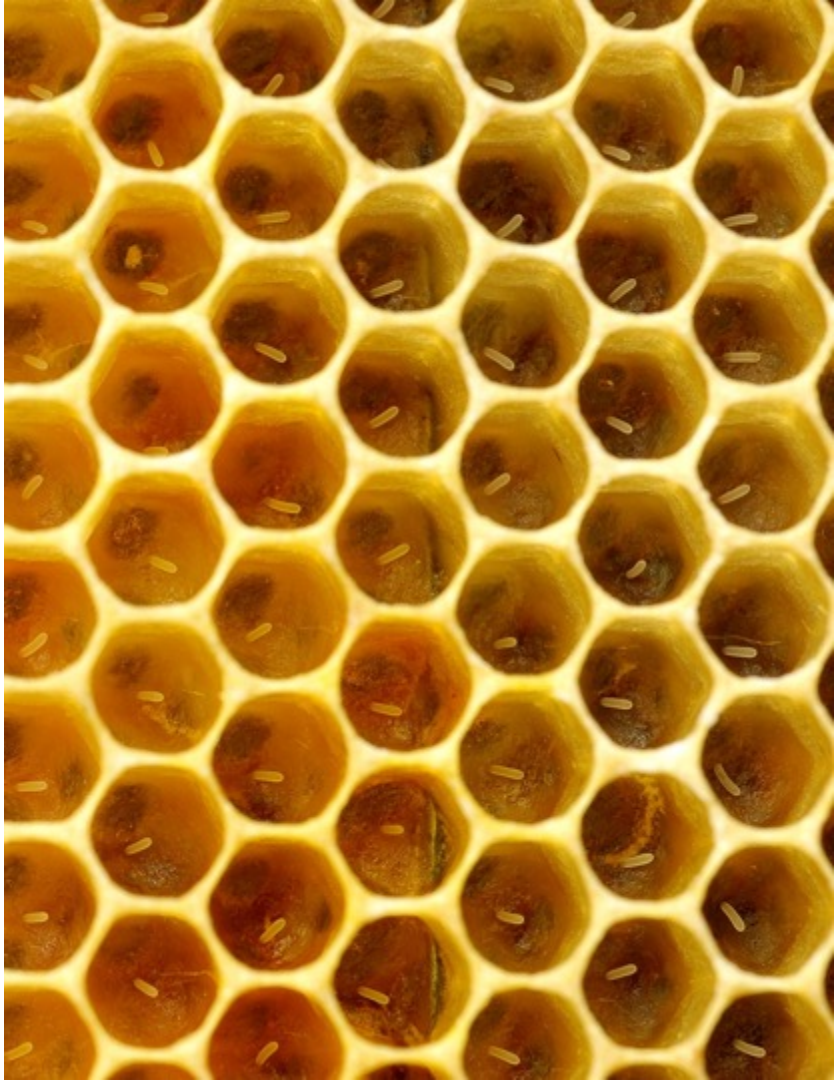
Marketing


THE
bees

The extraordinary, albeit short, life of the honey bee.

4 Days

The time it takes a honey bee egg to hatch into a larva.



1,300 MEALS

The amount of food a larva eats daily.

1,570x

In five days, the larva will grow more than 1,500x its original size.

IT'S A GIRL!

(probably)

The adult honey bee chews through the wax cap, joins the colony and gets to work.

11 DAYS

The honey bee stays in its hive after being born and performs a variety of tasks based on her age.

10 DAYS

The honey bee forages for food for the hive.

20,000

The number of flowers a bee visits in its lifetime.

500 Miles

The estimated distance a honey bee travels before its wings fail and the bee dies.

1/12 of a teaspoon

The amount of honey a bee produces in its lifetime.

What are honey bees?

- Genus: Apis
- Evolved 100 million years ago from predatory wasps.
- All native to Eurasia but spread to other continents via humans.

What makes honey bees unique?

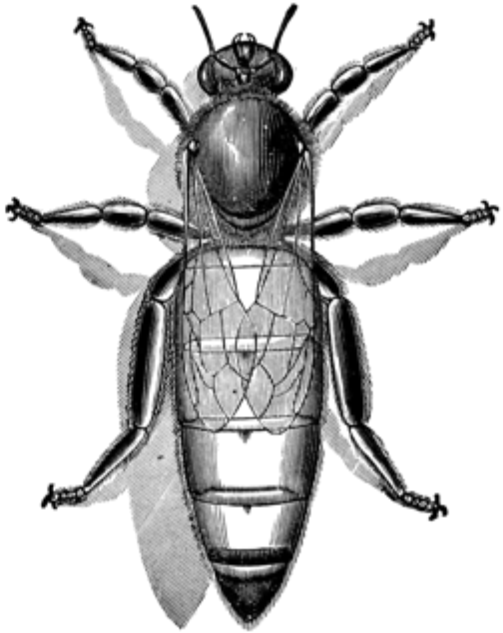
- A secondary stomach or “honey sac.”
- Build and live in colonies like ants and termites.
- Make and store honey.

Are there different types of honey bees?

20,000 known species of bees. Only seven species of honey bees are recognized.

- *Apis Mellifera* – European or Western honey bee
- *Apis Mellifera Liguistica* –Italian honey bee
- *Apis Mellifera Scutellata* – Africanized honey bee

DRONE.



QUEEN.

WORKER.

200
Men

1
Mom Bee

59,799
Women

The Queen Bee

- The sole egg layer in the hive, giving birth to up to 1 million bees in her lifetime.
- She's a home body, leaving the hive only once to mate.
- If she dies, so does the hive unless they "make" a new queen.

The Making of a Queen

- **Supercedure Cell:** An aging, ill, missing, dead or unfertile queen needs to be replaced.

- **Swarm Cell:** An overabundance of bees causes existing queen to leave the hive and start a new colony.

The Drone Bee

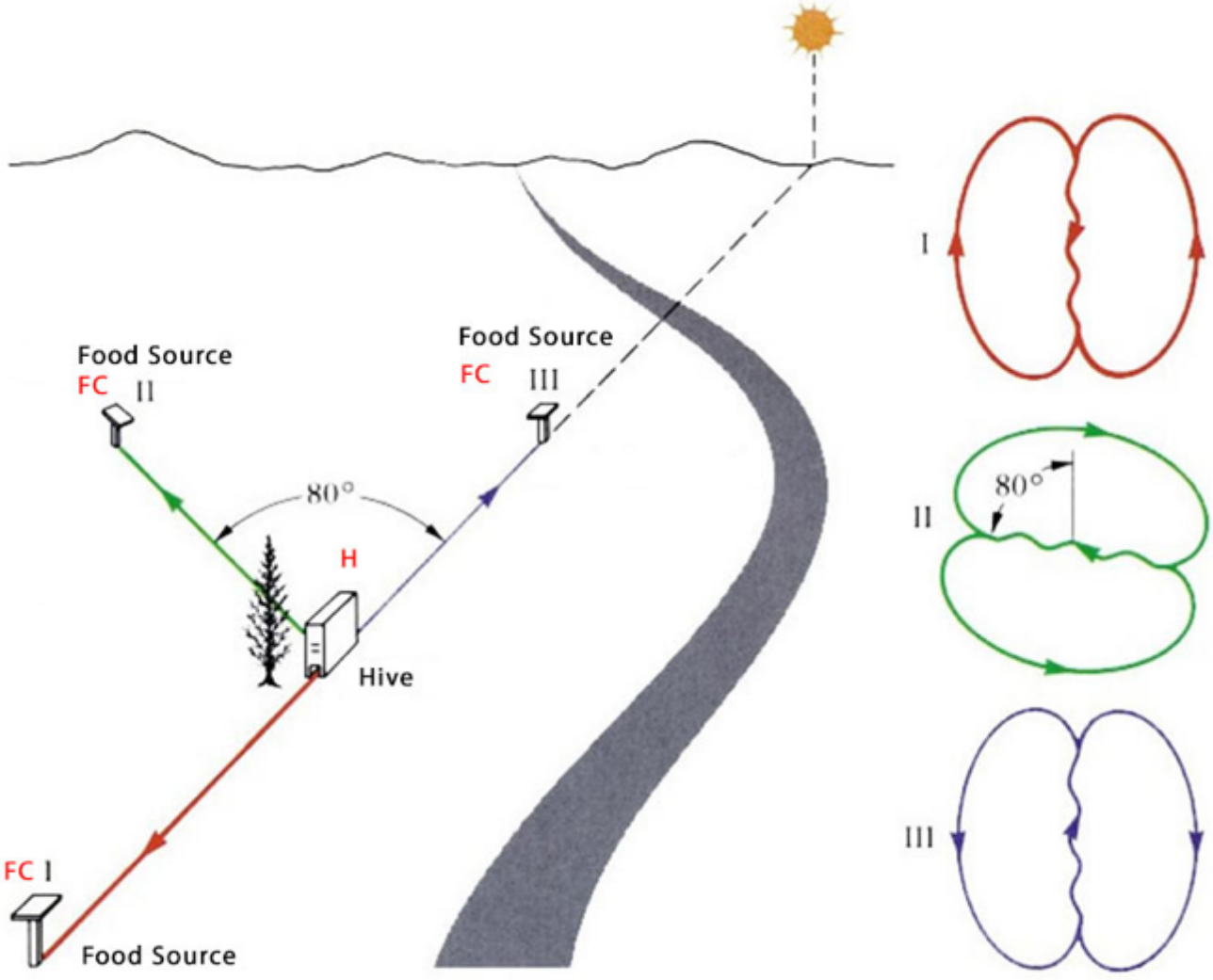
- They don’t have stingers and can’t forage.
- Sole role is to mate, which if successful, kills them.
- They get evicted from the hive once the weather starts getting colder.

The Worker Bee

- The "brain" and "body" of the hive. They make all the decisions and do all the work.
- Role in hive determined by age polyethism.
- They communicate through dance.

The Waggle Dance

1. Scout bees find a nectar source.
2. Analyze the quality of the nectar versus the distance traveled.
3. Map source of food using sun's position, landmarks, ultraviolet light and visual odometers.
4. Communicate location through Waggle Dance.


Food Source
FC II
Food Source
FC III
80°
H
Hive
FC I
Food Source
I
II
80°
III


THE
honey

FLOWER

BEE

HIVE

EXTRACTION

BOTTLE

FLOWER

BEE


BEE
HIVE


HIVE
EXTRACTION
BOTTLE

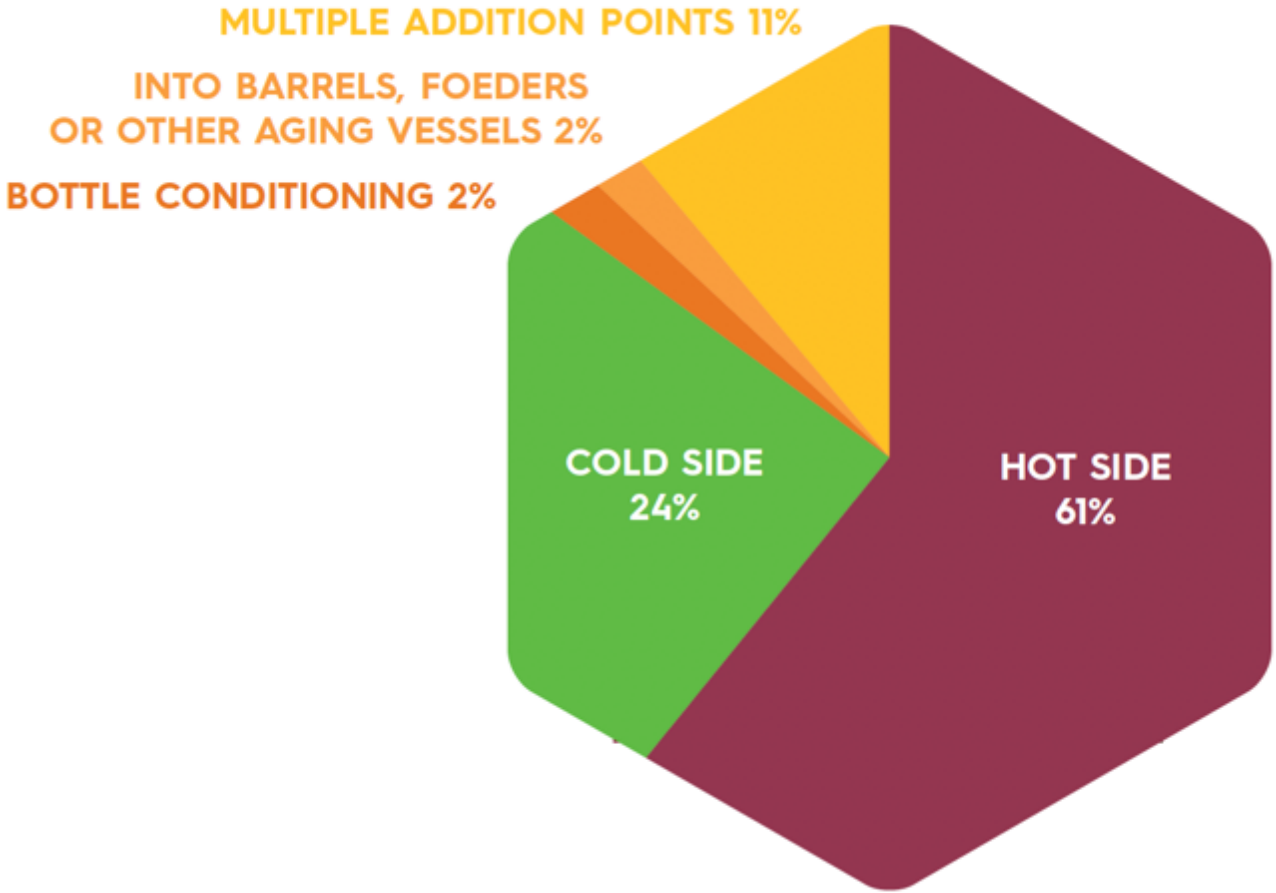

CHECK THE BASKETS
ENTERED BEFORE START

honey around the world

brewing with honey

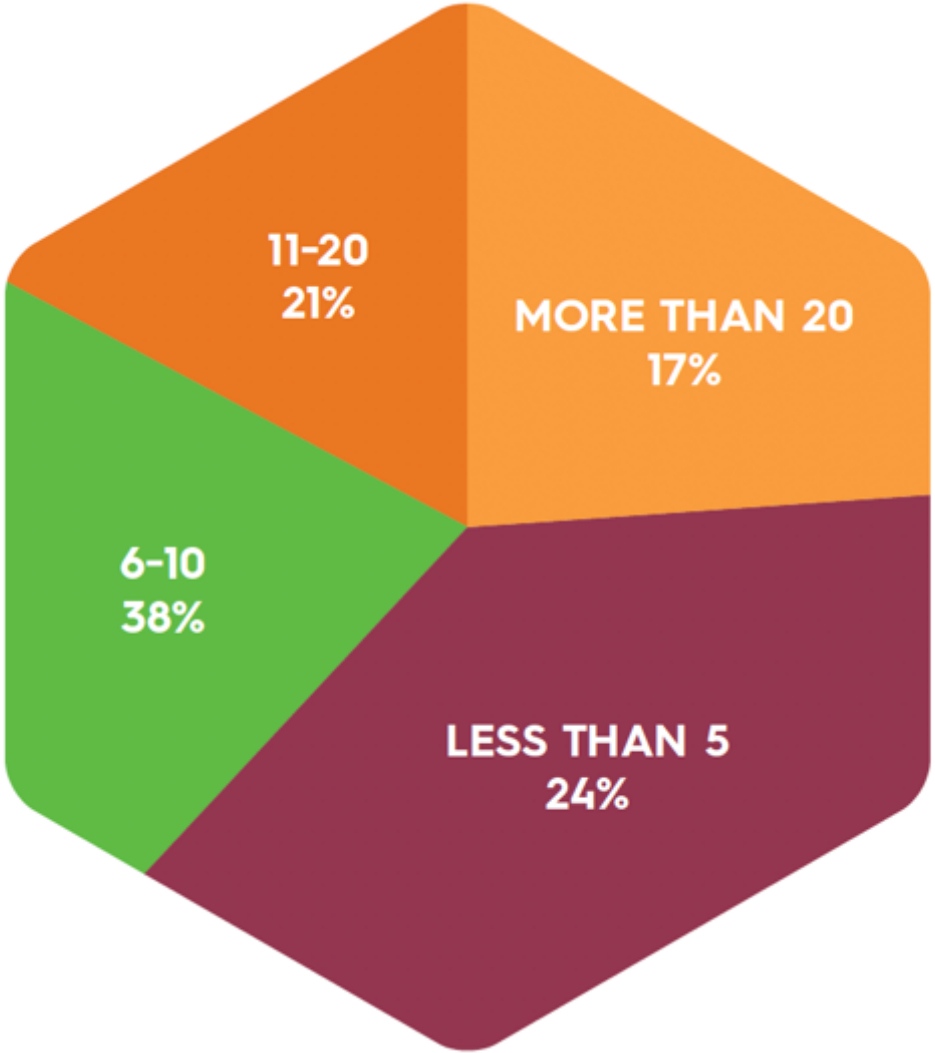
HONEY BEER COMPETITION
SURVEY 2019

Where did you add the honey?



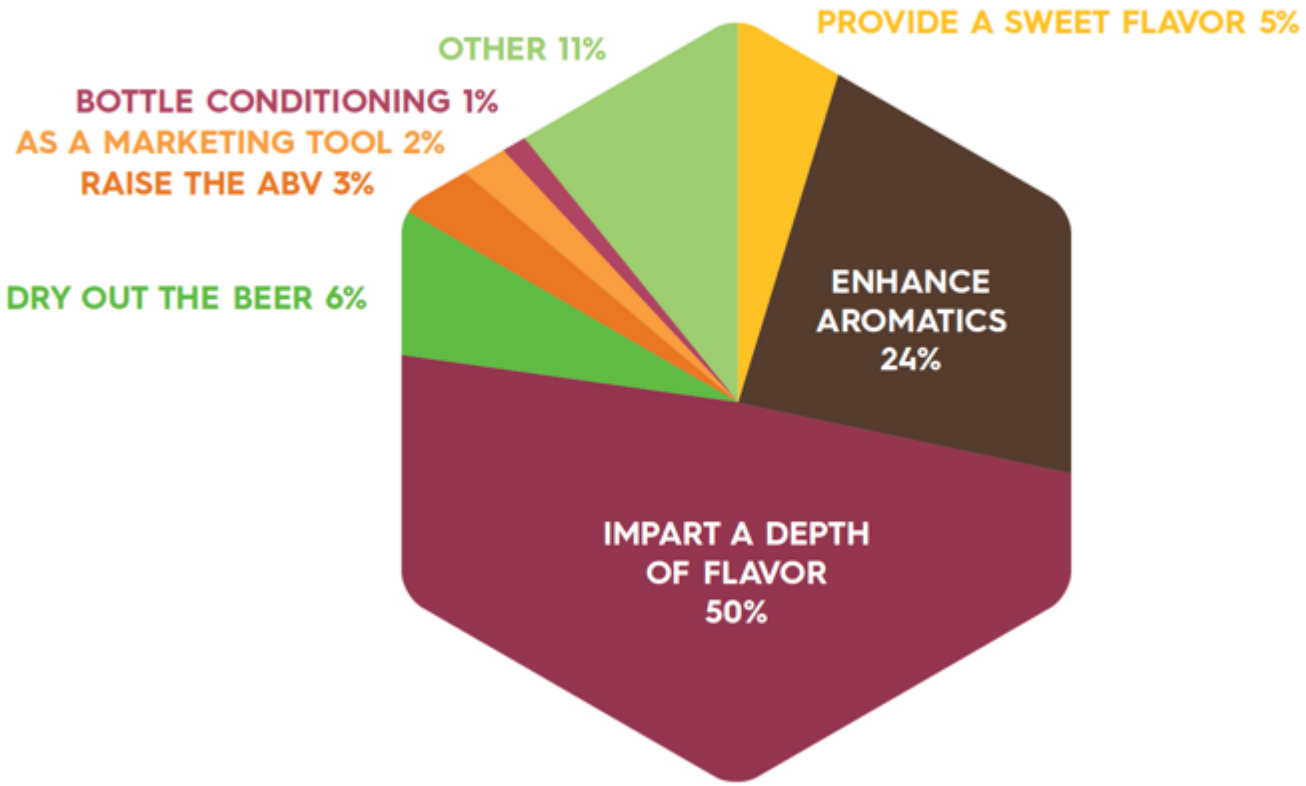
HONEY BEER COMPETITION SURVEY 2019

Percentage of honey used in recipe?



HONEY BEER COMPETITION
SURVEY 2019

Primary role of honey in the beer?



There is no “right” or “wrong” way to use honey in brewing.

The question: What are you looking to do?

Defining honey

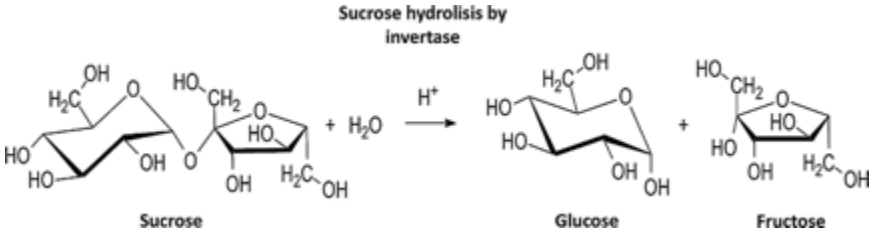
Official: *Honey sold as such shall not have added to it any food ingredient, including food additives, nor shall any other additions be made other than honey. Codex Alimentarius*

Technical: A complex supersaturated liquid containing more than 181 components, and containing more sugar than water can dissolve at ambient temperature.

Inspirational: Honey is simply honey. A pure, all-natural ingredient made in the world's most efficient manufacturing facility: the beehive.

THE CHEMISTRY OF HONEY!

Water (80%)
Sugars
Phytochemicals



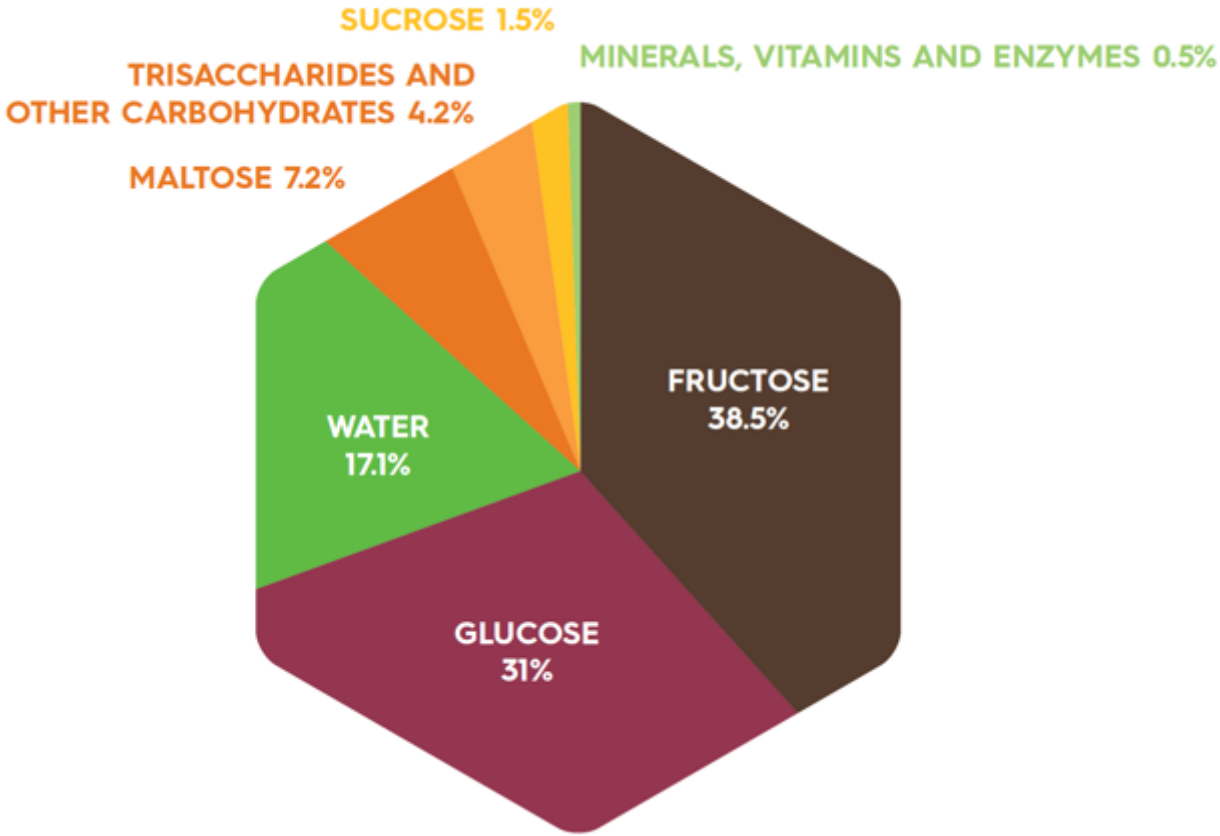
Sugars
Water (17%)
A whole bunch of other stuff

Honey composition

17%
Water

82%
Sugars

1%
Acids, minerals, vitamins, yeasts, bacteria, enyzmes



Concentration of multiple sugars gives honey its unique properties

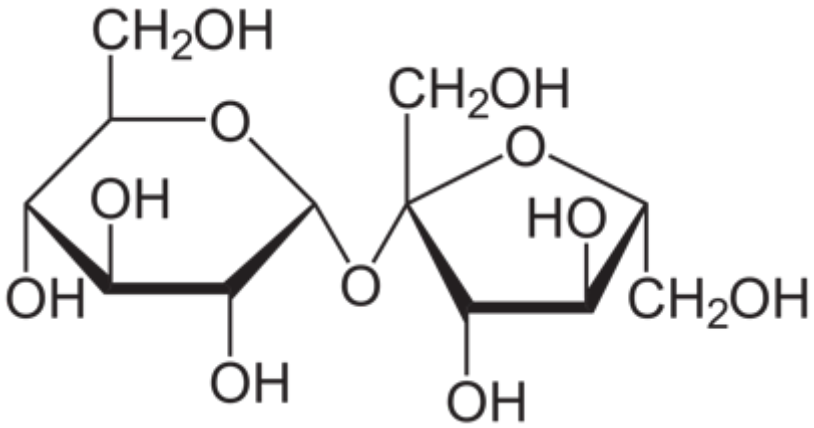
- The high viscosity of honey
- The stickiness of honey
- A high-density ingredient
- The tendency to granulate
- The ability to absorb moisture from the air
- An immunity from some types of spoilage

sugars

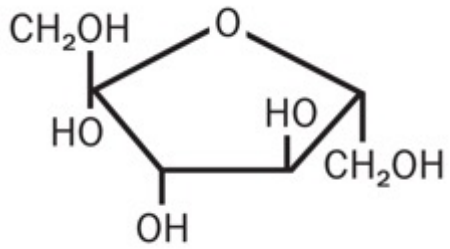
sweetness

SUGAR 101

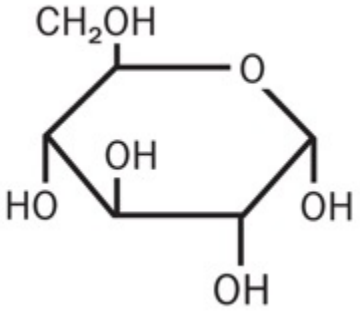
Sucrose $C_{12}H_{22}O_{11}$
Disaccharide



Fructose $C_6H_{12}O_6$
Monosaccharide



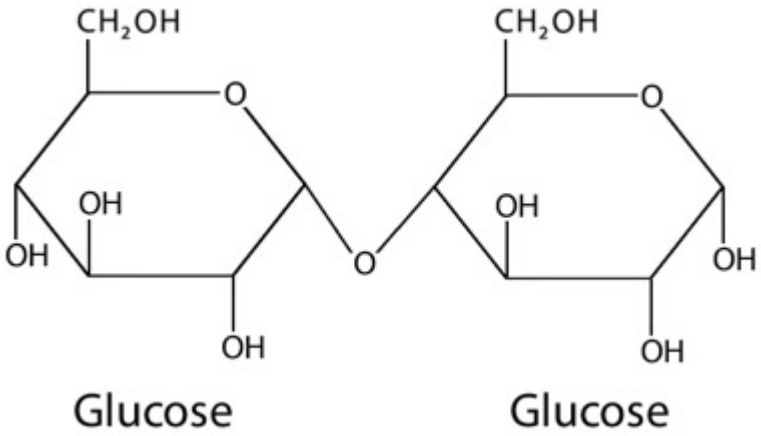
Glucose $C_6H_{12}O_6$
Monosaccharide



SUGAR 101

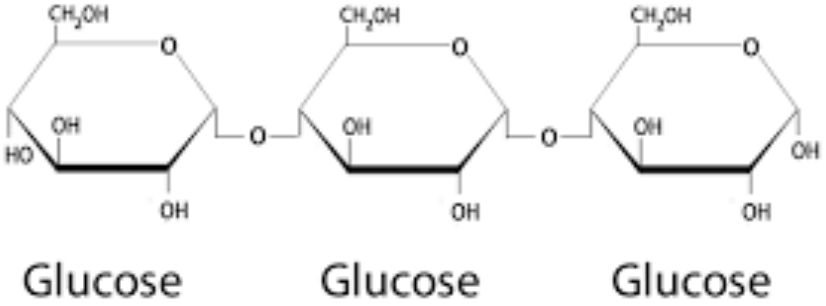
Maltose $C_{12}H_{22}O_{11}$

Disaccharide



Maltotriose $C_{18}H_{32}O_{16}$

Trisaccharide



Honey's Sweetness

Brix: 70-88

Relative Sweetness Scale

- Sucrose: 100
- Fructose: 140
- Glucose: 70-80
- Maltose: 30-50
- Lactose: 20

Honey's sugars

Monosaccharides – Simple Sugars

- Fructose: 38.2% - Sweeter than sucrose
- Glucose: 31% - Less sweet than sucrose

Disaccharides - 10

Sucrose, maltose, isomaltose, maltulose, turanose, kojibiose, nigerose, laminaribiose, B-trehalose and gentiobiose

Trisaccharides - 10

Melezitose, 3-a-isomaltosylglucose, maltotriose, I-kestose, panose, isomaltotriose, erlose, theanderose, centose and isopanose

Complex Sugars - 2

Isomaltoteraose and isomaltopentaose

Honey's sugars

Sweeteners	Relative Sweetness
Lactose	0.2
Corn Syrup	0.3
Barley Malt Syrup	0.5
Maple Syrup	0.6
Coconut Sugar	0.9
Sucrose	1
Honey	**1.1 to 1.5**
Agave Syrup	1.4
Stevia	300

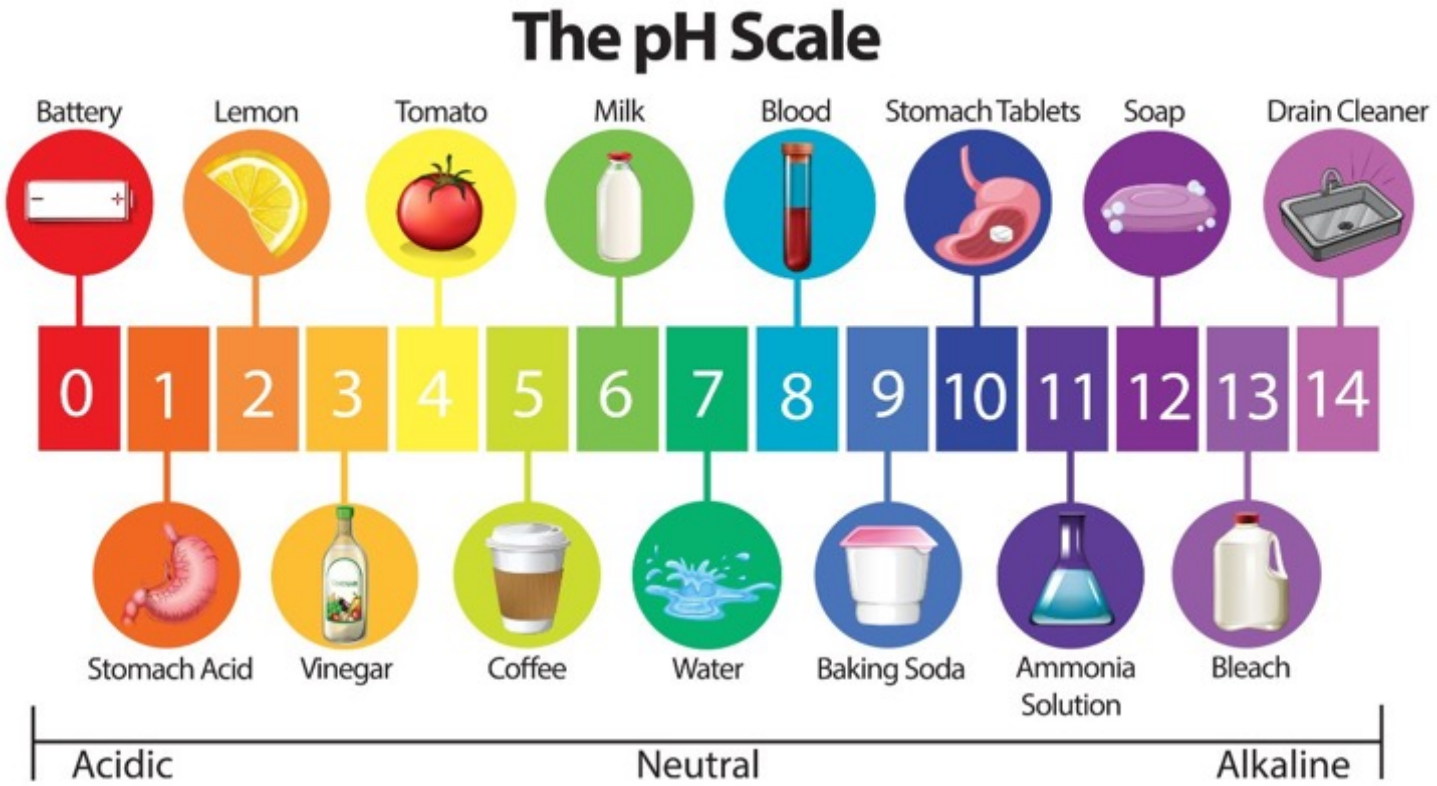
Honey Versus Wort

	Honey	European Lager	British Pale Ale
Fructose	46.2%	2.0%	3.5%
Glucose	37.8%	8.9%	10.6%
Sucrose	1.6%	2.2%	5.6%
Maltose	8.8%	51.1%	41.3%
Maltotriose		12.5%	12.1%
Maltotetraose		2.5%	2.1%
Higher Sugars	1.8%	20.8%	24.7%
Fermentability	94.4%	76.7%	73.3%

acids

flavor

ACID 101


The pH Scale
Battery
Lemon
Tomato
Milk
Blood
Stomach Tablets
Soap
Drain Cleaner
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Stomach Acid
Vinegar
Coffee
Water
Baking Soda
Ammonia Solution
Bleach
Acidic
Neutral
Alkaline

ACID 101

Honey has a pH of 3.9

The acid content in honey account for less than 0.5 percent of the solids, but its contribution to flavor is immeasurable.

The acidity also is partly responsible for the stability of honey against microorganisms.

Honey's acids

Organic acids: Acetic, butyric, citric, **gluconic,** lactic

Aliphatic acids: Interact with the flavors of other ingredients when used in food and beverage products with honey

Aromatic Acids: Found in monofloral and help indicate floral source

Lactones: Considered a reserve acidity, since by chemically adding water to them (hydrolysis) an acid is formed. Significant flavor contributions.

Amino Acids: Very small amount

Gluconic Acid

Initially imparts a sweet taste, which later becomes slightly acidic.

Flavor-enhancing acid that complements spices, herbs and hops.


CARBS
ACID

the 1%

Volatile Organic Compounds

Provides a fingerprint of a specific honey from a specific time and place.

Greatly impacts aroma of honey:

- Furfural – Sweet, fruity, soft almond
- Benzene acid – Ripe fruit, spiciness
- Pantolactone – Woody, toasty, caramel

Enzymes

One of the characteristics that sets honey apart from all other sweeteners is the presence of enzymes.

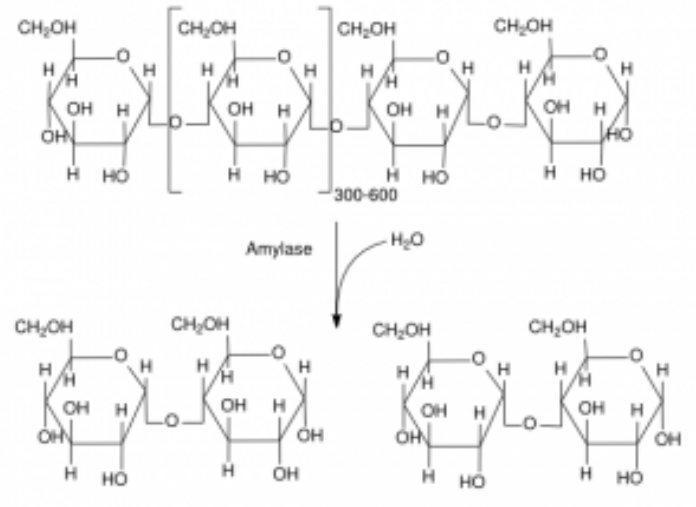
Enzymes are derived from bees, pollen, nectar and micro-organisms in honey. **Enzyme levels are dependent on floral source and age of bees.**

Honey's enzymes: Amylase / Diastase

Where does it originate?
Believed to originate from pollen.

What does it do?
Converts starch to dextrins and sugars. Also can be used to indicate how "fresh" honey is. Amylase levels will decrease via time or temperature.

- Honey: 9-37 Dextrinizing Units
- Malted Barley: 24 Dextrinizing Units



Does it play a role in brewing? It can

Honey's enzymes: Amylase / Diastase

Some honeys contain diastase (amylase) in similar levels as malted barley.

- Result: If not denatured by heat, these enzymes could go to work in your fermenting wort, resulting in a beer with lower final gravity (i.e. drier than you might have intended).
- Result: Can also impact carbonation if used for keg/bottle conditioning.

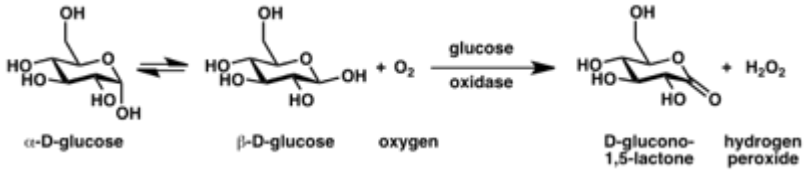
Two methods used to eliminate these enzymes:

1. Add honey during wort boil to deactivate enzymes (at least 10+ minutes).
2. Heat-treat honey if using on the cold side.

Honey's enzymes: Glucose oxidase

Where does it originate?
The pharyngeal gland of the honey bee.

What does it do?
Catalyzes glucose to gluconolactone, which then forms gluconic acid and hydrogen peroxide.



Does it play a role in brewing? Yes!
Responsible for the main acid in honey.
Acid = flavor.

The 1%: Polyphenols

Honey has polyphenols. Darker honeys have a higher polyphenol content.

- Compared to malted barley, however, honey contributes significantly less polyphenols (tannins) to final beer.

- **Outcome:** Honey has very little potential to develop astringent polyphenolic-derived flavors and permanent or chill haze formation in the final beer.

Color Type	Color (mm Pfund)	Polyphenols (mg/kg)
White	31	250
Extra Light Amber	35	269
Extra Light Amber	39	292
Extra Light Amber	42	274
Light Amber	56	303
Light Amber	71	305
Dark Amber	151	548
Dark Amber	156	444
Dark Amber	160	535
Dark Amber	167	509

The 1%: Nitrogen

Honey's nitrogen levels are relatively low (0.04 to 0.2%) compared to malted barley (1.5 to 2.5%; dry basis).

- **Outcome:** Low to moderate usage rates of honey (< 20% of total extract) should not impact yeast fermentation performance.

- **Outcome:** Higher usage rates could result in a yeast nutrition issue and reduced fermentation performance (i.e. delayed/longer fermentations; worse case: stalled fermentation).

The 1%: Vitamins, minerals and antioxidants

Vitamins
B vitamins: riboflavin, niacin, folic acid, pantothenic acid, B6
C vitamins: ascorbic acid

Minerals
Calcium, iron, zinc, potassium, phosphorous, magnesium, selenium, chromium, manganese

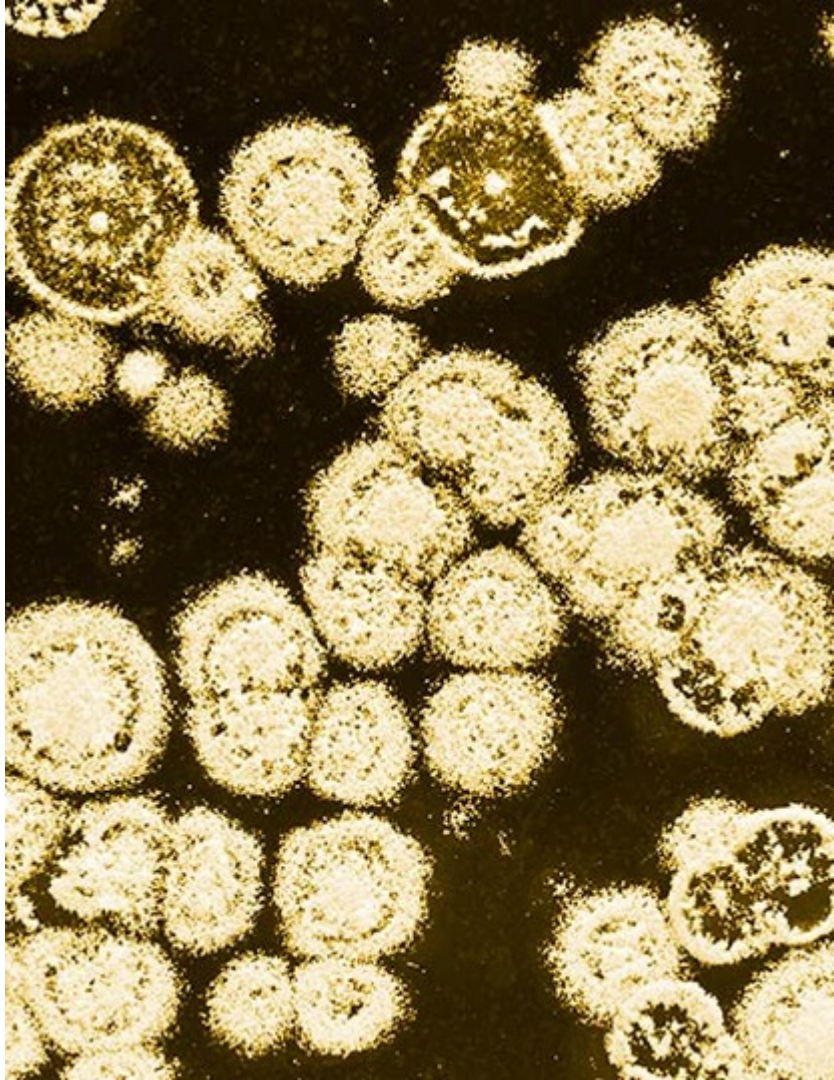
Antioxidants
Pinocembrin, ascorbic acid, catalase

The 1%: Microbials

Honey has microorganisms, such as wild yeast and bacteria. They remain dormant due to acidity of honey (3.9 pH).

- **Outcome:** Once diluted in water or wort, honey can support the growth of non-pathenogenic microbes which can cause beer to spoil and become sour.

Challenge: How to avoid potential for microbial contamination while still preserving the subtle flavors and aromas of the honey?



Finding the sweet spot: Heat treatment

Pasteurization study looked at time and temperatures needed to inactivate honey's microbials while maintaining aromatics and flavor.

- 1:1 dilution with water at 185° F for 20 minutes

Sensory differences among the three treatments were subtle and some panelists commented that it might be hard to distinguish the beers in a discriminative test (e.g. a Triangle Test).

Sample	ABV	RE (°P)	AE (°P)	OG (°P)	RDF (%)	Color (ASBC)	pH	BU
Control	6.2	3.4	1.2	12.8	74.7	5.3	4.31	24.00
T20	5.8	3.5	1.4	12.3	73.1	5.6	4.27	22.70
T60	5.7	3.4	1.4	12.1	72.8	5.6	4.30	24.30

honey and fermentation

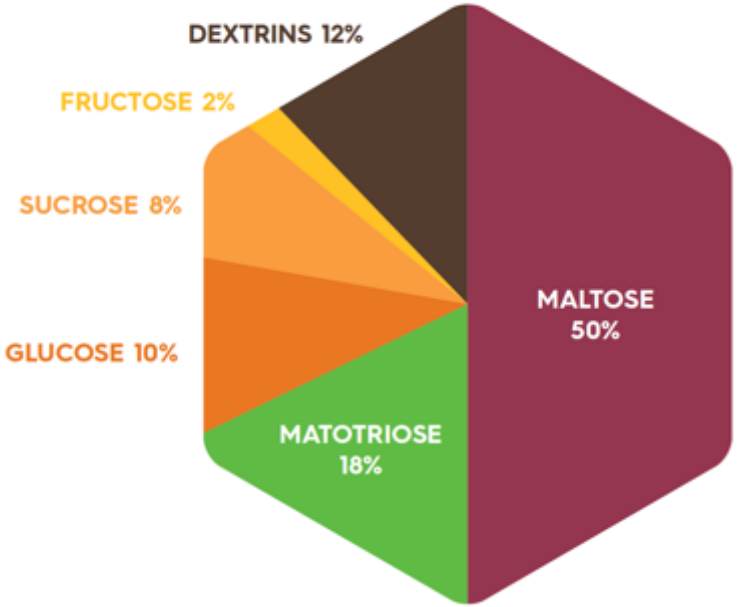
HONEY FERMENTATION

The yeasts naturally occurring in honey are osmophilic, meaning they can germinate and group at much higher sugar concentrations.

Moisture Content	Will it ferment?
Less than 17.1%	No, regardless of yeast count
17.1% to 18%	No, if yeast count is less than 1,000/g
18.1% to 19%	No, if yeast count is less than 10/g
19.1% to 20%	No, if yeast count is less than 1/g
Above 20%	Yes

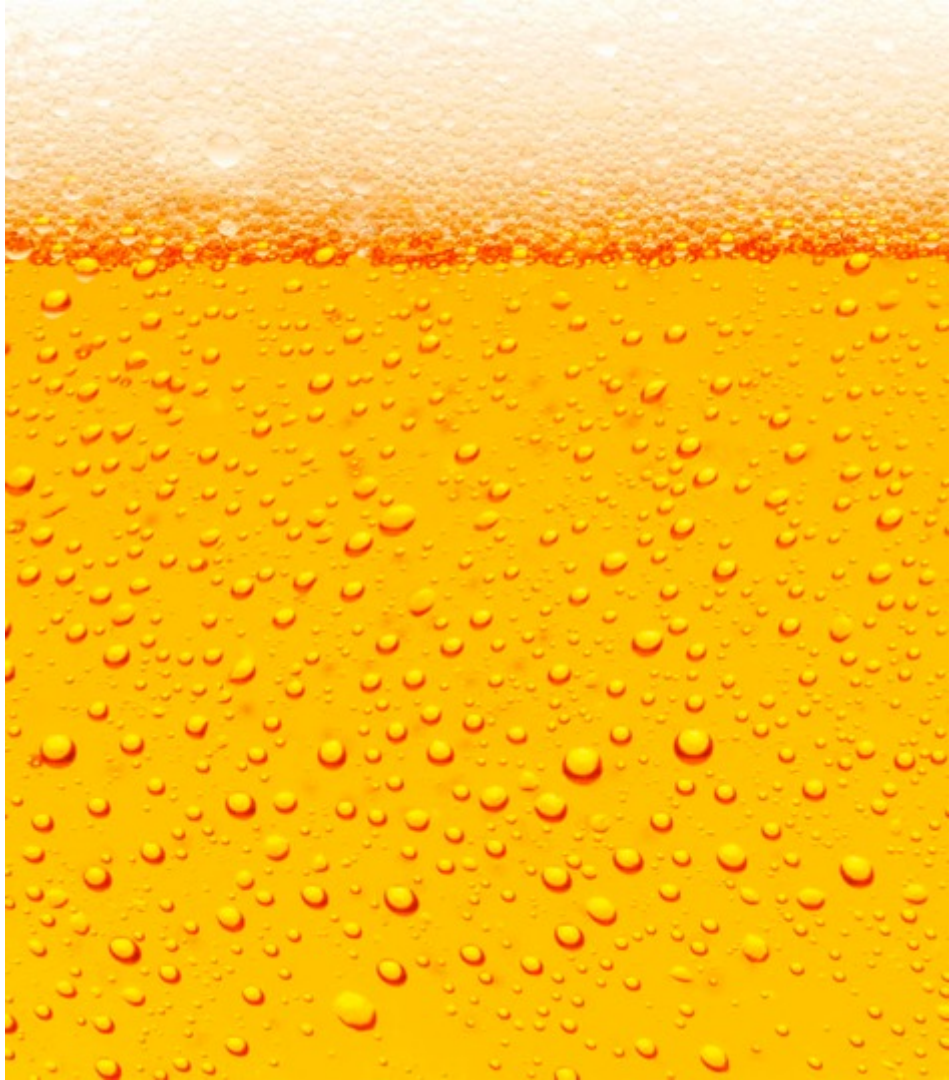
BEER FERMENTATION

Typical wort: 2-row barley base



The dietary sequence of Traditional beer yeast strains

1. Sucrose: Disaccharide
   - Glucose
   - Fructose
2. Glucose: most yeast strains are glucophilic
3. Fructose
4. Maltose
5. Maltotriose



HONEY BEER FERMENTATION

	Honey	European Lager	British Pale Ale
Fructose	46.2%	2.0%	3.5%
Glucose	37.8%	8.9%	10.6%
Sucrose	1.6%	2.2%	5.6%
Maltose	8.8%	51.1%	41.3%
Maltotriose		12.5%	12.1%
Maltotetraose		2.5%	2.1%
Higher Sugars	1.8%	20.8%	24.7%
Fermentability	94.4%	76.7%	73.3%

Warning: Honey usage over 12% can stall fermentation.

The dietary sequence of Traditional beer yeast strains

1. Sucrose
2. Glucose
3. Fructose
4. Maltose
5. Maltotriose

HONEY BEER FERMENTATION

Why use sugars other than what comes naturally from barley?

1. Raise ABV without increasing body
2. Lighten the body while maintaining ABV
3. To prime the beer for carbonation

Why use honey?

1. Add flavor
2. Add complexity and depth
3. Smooths out "roughness" that comes from adding other sugars
4. Enhance hop flavor, aroma

HONEY BEER FERMENTATION

Honey is 95% fermentable, which is why honey beers don't necessarily mean sweet beers.

What about the remaining 5%, and is it worth the ingredient cost? Yes! According to these brewers.....

- "After fermentation, honey gives a grassy, earthy flavor to beer." ***Goose Island***
- "You don't get sweetness but you do get a subtle honey note in the background. While subtle, the honey provides complexity compared to other sources of fermentable sugars." ***Elevation Brewing***

brewing with honey


MILLING
MASHING
BOILING + WHIRPOOL
FERMENTING
CARBONATING
BARREL AGING

hot side addition

The Boil

Balancing act between inactivating microbials, denaturing enzymes and maintaining honey's aromatics and flavor.

Consideration

When do you add honey during the boil?

- Denature vs. essence of honey

Consideration

How much honey are you using?

- Over 15% honey may trigger catabolite repression on maltose utilization.

The Boil

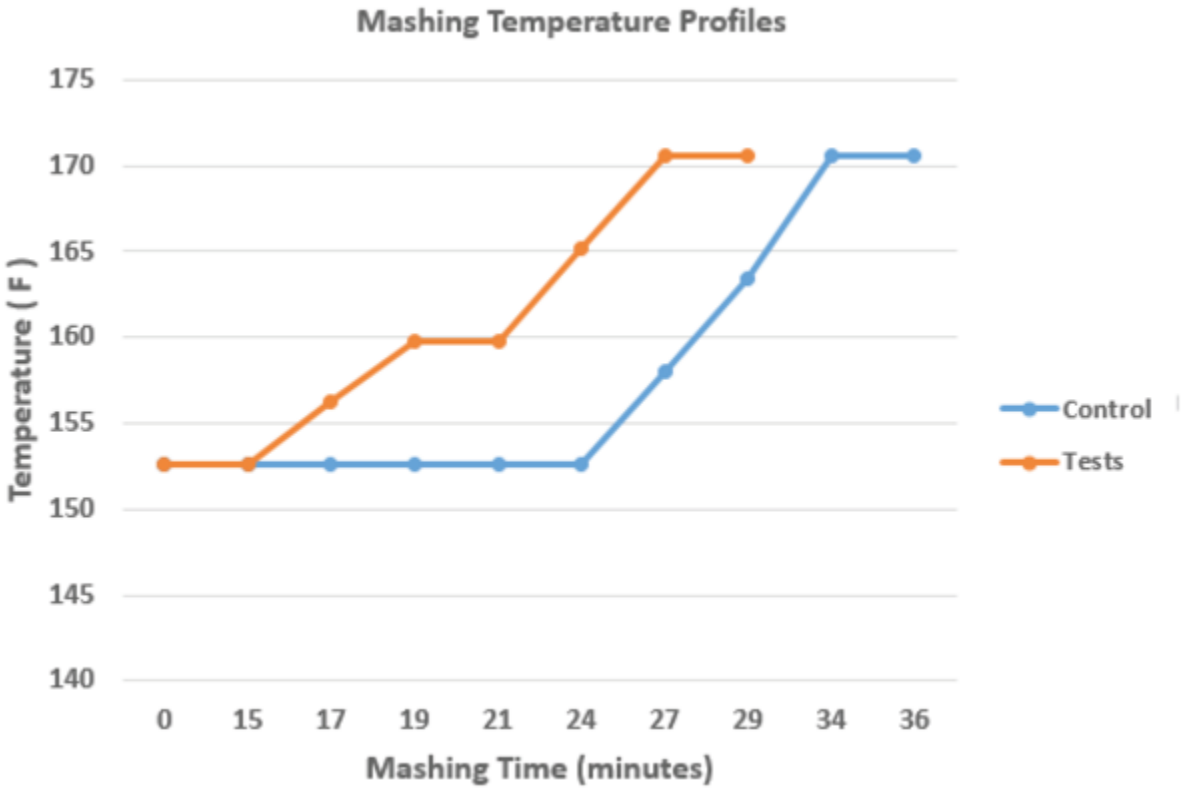
Expectation

Raise the ABV of the beer and create a lighter body and drier by maintaining mash temperatures between 150-155°F.

Expectation

Raise the abv of the beer without changing its body by increasing the mashing temperature.

Mitigating honey's impact on body through mashing temperatures



Beer chemistry post-fermentation with modified mashing schedule

	CONTROL (NO HONEY ADDITION)	HONEY ADDED AT END OF BOIL	AT FERMENTATION START	AT 48 HOURS OF FERMENTATION
Apparent Extract (°P)	2.4	2.4	2.2	2.4
Ethanol (% v/v)	4.8	4.9	5.0	4.9
ADF (%)	78.8	79.1	80.9	79.4
Calculated OE (°P)	11.4	11.6	11.6	11.7
Real Extract (°P)	4.2	4.2	4.0	4.2
Ethanol (% w/w)	3.7	3.8	3.9	3.9
Color (SRM)	7.7	8.1	7.3	7.1
pH	4.4	4.2	4.2	4.2

Beer chemistry post-fermentation with consistent mashing schedule

	CONTROL (NO HONEY ADDITION)	HONEY ADDED AT END OF BOIL	AT FERMENTATION START	AT 48 HOURS OF FERMENTATION	FOR BOTTLE CONDITIONING
Apparent Extract (°P)	2.56	2.16	2.09	2.06	2.64
Ethanol (% v/v)	4.68	4.91	4.89	4.82	4.58
ADF (%)	77.48	81.10	81.54	81.55	76.59
Calculated OE (°P)	11.38	11.42	11.34	11.17	11.27
Real Extract (°P)	4.26	3.94	3.87	3.82	4.30
Color (SRM)	4.99	4.66	4.77	4.53	6.00
BU	23.9	23.1	22.5	21.8	25.9
Turbidity (FTU)	25.2	20.8	27.7	21.8	7076.0
pH	4.19	4.01	4.13	4.04	4.18

The Boil

Expectation
A slight decrease in beer color.

Expectation
Creates balance between honey and targeted beer style.

Expectation
No residual sweetness, minimal aromatics.

Expectation
Smooth out bitter edges of hops.

Flameout / Whirlpool

Preserving honey's essence, but not its sweetness.

Consideration
To apply heat treatment to honey or not?

Expectation
Less heat means more of honey's essence will be carried through to finished beer, especially the aromatics and complexity of flavors.

cold side addition

Fermentation

Preserving the sweetness and aromatics of honey and its many varietals.

Consideration
When do you add honey during the fermentation process?

- **In the Beginning:** Will cause a robust fermentation, may trigger catabolite repression and scrub out honey's essence.

- **At Peak Fermentation:** Yeast is in a highly active state and able to handle honey's sugar profile without completely drying out the beer.

Fermentation

Consideration

How much honey are you using?

- A little bit is going to go a long way.

Consideration

How to add honey?

- Dilution with water or mechanical agitation.

Expectation

Minimal sweetness with strong aromatics and depth-of-flavor.

Conditioning

Do you want the priming sugar hidden in the background?
Use sugar.

Do you want the priming sugar to play a role in the beer?
Use honey, which will provide an accent to the beer.

Honey also "may"....
- Clean up the beer faster.
- Reduce THP production.

Barrel Aging

Research pending…What's your experience?

"Expect honey to become more floral and complex as it ages."

Multi-Stage Addition

In the boil:
Raise ABV and lightens body.

After primary fermentation:
Provide honey flavor profile.

In the barrel:
Expect honey to become more floral and complex as it ages.

Bottle conditioning

Descriptive Sensory Panel Results

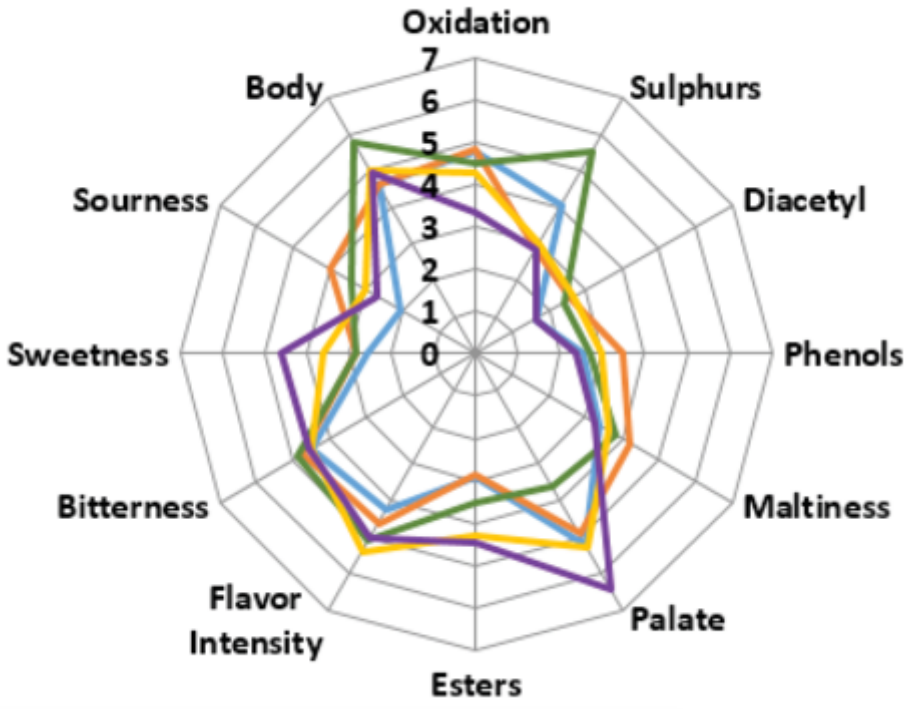
Control

End of Boil

Fermentation Start

48 Hours After Fermentation

Bottle Conditioning



handling honey

Storage and handling of honey

When stored properly, honey will “never” go bad!

Short term storage: Less than two years

- Room temperature: 64-75°F Minimize temperature fluctuations (don’t store near oven)
- *Air-tight containers are a must*

Long term storage: More than two years

- Freeze it!
- Over time, honey will darken and start to lose flavor / aroma

The crystallization of honey

What is it? A natural and spontaneous phenomena when glucose separates from water and comes out of solution.

- Glucose molecules start sticking to each other, or cling onto a spec of dust or pollen.
- Honey crystallization is most rapid around 50-59°F.
- Honey resists crystallization best at temperatures more than 77°F.

Does it impact honey quality: No!

What can I do about it? Heat the honey in a water bath to return it to its liquid state.

Best practices

1. Warm honey by sitting it in a hot water bath to make it more pourable. Crack the lid as it will expand.
2. Avoid adding honey too quickly to kettle to avoid scorching honey. Use mechanical agitation or re-circulation of hot wort to dissolve honey.
3. Dilute honey with hot brewing water, hot wort, beer or de-aerated water to help honey dissolve easier.
4. Never leave containers open.
5. Save some for the lunchroom.

Honey.com


National Honey Board
HOME
ABOUT HONEY
BEES & SUSTAINABILITY
RECIPES
LOCATOR
FIND HONEY
sign up or log in
By State
Select a State
By zip code
Enter zip code
Advanced search options
United States
Mexico

www.honeybeercompetition.com

questions

Keith Seiz, **keith@honey.com**