Brewing With Fruit
Kevin Wright – Hangar 24 Brewery

Overview

- Fruit Characteristics important to Brewing
- Available Fruit Products
  - Manufacture of
  - Processing Pros/Cons
- Adding Fruit to Beer
  - When in process
  - Yeast Impacts
  - Flavor Impacts
- Microbiological Impact

Nutrient Content (Fresh Fruit)

<table>
<thead>
<tr>
<th>Nutrient Content (Fresh Fruit)</th>
<th>Sugar (%)</th>
<th>Water (%)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apricot</td>
<td>9.2%</td>
<td>86.4%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Blueberry</td>
<td>10.0%</td>
<td>84.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Cherry(Sour)</td>
<td>8.5%</td>
<td>86.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Cherry(Sweet)</td>
<td>12.8%</td>
<td>82.3%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Orange</td>
<td>9.4%</td>
<td>86.8%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Raspberry</td>
<td>4.4%</td>
<td>85.8%</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

http://www.ars.usda.gov/SP2UserFiles/Place/12354500/Data/SR24/reports/sr24fg09.pdf
Sugar Breakdown (Fresh Fruit)

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Total Sugar</th>
<th>Sucrose</th>
<th>Glucose</th>
<th>Fructose</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranberry</td>
<td>10.4%</td>
<td>63.5%</td>
<td>25.6%</td>
<td>10.2%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Raspberry</td>
<td>9.2%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>49.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Orange</td>
<td>9.4%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Apricot</td>
<td>9.5%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Blueberry</td>
<td>9.6%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tangerine</td>
<td>9.7%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Blackberry</td>
<td>9.8%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cherry</td>
<td>9.9%</td>
<td>10.0%</td>
<td>49.0%</td>
<td>26.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Acidity (pH & TA)

- pH
  - Measure of [H+] ions
  - Dissociated
  - Gives indication of acidic "strength"
  - Many impacts (buffers)
  - Measured by Meter
  - More impact on Processes

- Total Acidity (TA)
  - Measures amount of Acids
  - Dissociated & Bound
  - Used Primarily in Wine & Mead Making
  - Measured by Titration
  - Malic, Citric & Tartaric
  - More impact on Taste & Mouthfeel
  - Wine Levels: 0.50% - 0.85%
  - Mead: 0.35% - 1.0%
  - Beer: 0.3% - 1.5%
Acidity (pH & TTA)

<table>
<thead>
<tr>
<th>Type</th>
<th>pH</th>
<th>Type</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apricot</td>
<td>4</td>
<td>Malic</td>
<td>3.5</td>
</tr>
<tr>
<td>Blueberry</td>
<td>4</td>
<td>Citric</td>
<td>3.3</td>
</tr>
<tr>
<td>Cherry (Sour)</td>
<td>4</td>
<td>Malic</td>
<td>3.2</td>
</tr>
<tr>
<td>Cherry (Sweet)</td>
<td>3</td>
<td>Malic</td>
<td>4.5</td>
</tr>
<tr>
<td>Orange</td>
<td>4</td>
<td>Citric</td>
<td>3.5</td>
</tr>
<tr>
<td>Raspberry</td>
<td>4</td>
<td>Citric</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Tannins

- Polyphenol Compounds found in Grain Husks, Hops, Spices, Fruits, etc
- Astringency sensation in Mouthfeel
- Haze
- Balance in character
- Wide variety & intensity in Fruit Products
- Decrease as Fruits Ripen

Tannins in Fruit

- High Tannins
  - Apricots
  - Berries (Black, Blue, Rasp)
  - Currants
  - Peaches
  - Persimmons
  - Pomegranates
- Medium Tannins
  - Apples
  - Cherries
  - Grapes
- Low or No Tannins
  - Bananas
  - Citrus Fruits
  - Pineapple
  - Strawberries
  - Watermelon

Pectin

- Polysaccharide found in Plants
- High concentration in Skins
- Used primarily in Jam Production also in Pharmeceuticals
- Can Cause Haze in Beer
- Needs High Temp to “Set” (180F)
- Cleared with Pectinases
**Fruit Products Available**
- Fresh
- Frozen
- Puree
- Concentrate
- Dehydrated
- Freeze-Dried
- Powdered
- Extract & Essence

**Fresh Fruit**
- Locally Picked/Sourced
- Ripeness important — ripe flavor & aroma vs appearance
- Use resources to obtain
  - Work with Local Farmers
  - Farmers Markets
  - Contact Packing Houses
  - Fruit Boards
  - Ag. Department

**Fresh Fruit Pros & Cons**
- **Pros**
  - Local Partnership
  - Authenticity
  - Flavors & Aromas
  - Variety
  - Know the Source
  - Can be Cheaper
    - Local = Less Shipping
    - Less than Perfect Appearance
- **Cons**
  - Availability
  - Seasonality
  - Regionality
  - Difficult to Process
  - Consistency
  - Difficult to Incorporate
  - Pesticides & Fertilizers
  - Microbial Contamination Risk
  - Shelf Life
  - Solids

**Processing Fresh Fruit**
- **Juicing**
- **Pureeing**

Doing it Yourself vs. Sourcing Out — Talk with Growers
Frozen Fruit

- Commercially Bought or Do-It-Yourself
- Effect on Cellular Structure
  ◦ Flash Freezing vs. Regular Freezing
- Similar Pros & Cons to Fresh Fruit
  ◦ No Seasonality
  ◦ Less Contamination Risk
  ◦ Potential Flavor Loss
  ◦ Storage Space/Costs
  ◦ Check for Additives

Fruit Puree

- Should be 100% fruit
- Fruit pressed through various sized screens
- Some Loss of Material
  ◦ ~20% (by weight) for Pitted Fruit
  ◦ ~12% for Seeded Fruit
- Flash Pasteurized
- Packaged Aseptically

Fruit Puree Pros & Cons

- Pros
  ◦ Easier to work with
  ◦ Aseptic
  ◦ Consistent
  ◦ Availability
- Cons
  ◦ Expensive
  ◦ Heavy
  ◦ Heat Pasteurization
    ◦ Flavor Degradation
    ◦ Pectins
    ◦ Source
    ◦ Storage
    ◦ Solids

Fruit Puree – Solids Testing

- 15 mL puree (6 samples each) Massed
- Centrifuge 10 min
- Supernatant Liquid Removed
- Precipitate Massed
- Percentages (average)
  ◦ Apricot: 34.2% Solids
  ◦ Blueberry: 55.2% Solids
  ◦ Cherry: 51.4% Solids
  ◦ Raspberry: 39.9% Solids
- Some Potential Breakdown by Yeast
Fruit Concentrate
- Fruit cleaned, separated, pureed & pasteurized (if concentrate is frozen)
- Cold Extraction
- Evaporation Plant
- Finished Sugar Concentration: 10 – 65 Brix
- Pasteurization
- Concentrated Puree
- Concentrated Juice (more processing)

Fruit Concentrate Pros & Cons
- Pros
  - Easy to Use
  - Consistent
  - Less Storage Space
  - Aseptic
- Cons
  - Flavor Degradation
  - Heat processing = pectin
  - Costs?
  - Processing Aids
  - Origin
  - Solids (Puree)

Dehydrated Fruit
- Start with Fresh Whole or Sliced Fruit
- Dehydrator to Dry (Slight Heating)
- Finished Product has 10-15% Moisture

Dehydrated Fruit Pros & Cons
- Pros
  - Flavor Concentration
  - Less Space
  - Lower Cost
  - Less Water Added
- Cons
  - Processing Aids
  - Preparing for Use
  - Flexibility
  - Flavor Extraction
  - Flavor Degradation
  - Consistency
  - Origin
  - Solids
**Freeze Dried Fruit**

- **Freeze Drying Process**

  ![Diagram](image-freeze-drying.png)

- **Fruit Rapidly Cooled to Freeze Water**
  - Rapid Freezing Protects Cellular Structure

- **Pressure Reduced with Slight Heat to Promote Sublimation**
  - Finished Moisture ~1%

**Freeze Dried Fruit Pros & Cons**

- **Pros**
  - Availability
  - Very Light
  - Very Stable
  - Less Needed
  - Flavor Integrity
  - Minimum Water
  - Astronaut Technology

- **Cons**
  - Check for Processing Aids
  - Use in Production
  - Cost
  - Consistency?
Fruit Powder

- Starts as Dehydrated Fruit
- Dried to 3% Moisture
- Milled to Size (Pieces, Granules, Powder)
- Pros & Cons Similar to Dehydrated
  - Easier to Use
  - Faster Flavor Extraction

Fruit Extract

- Natural vs. Artificial
  - Natural: “Natural” Source (WONF)
  - Artificial: Manufactured Flavor & Aroma Chemicals
- Solvent Extract
  - Alcohol
  - CO2
  - Propylene Glycol
- Cold Press/Maceration & Settling
- Homogenized Oils
- Powdered Extract = Spray Dried

Fruit Extract Pros & Cons

- Pros
  - Simple to Use
  - Extremely Consistent
  - Low Cost
  - Easy Storage
  - No Pectins
- Cons
  - Flavor Authenticity
  - Production Of
  - Balance Needed
  - “Real” vs “Not Real”
  - Labeling

Adding Fruit

- Mash
- Kettle
- Whirlpool
- Fermenter
- Long-Term Storage
- At Packaging
Mashed Fruit?

- Most Practical for Whole or Pureed
- Easy to Add
- Easy to Clean up “Fruit Trub”
- No Risk of Contamination
- Limited Pectin

Verdict: Not Most Practical

Kettle Addition

- Easy To Add
- No Contamination Risk
- Removal of “Fruit Trub”
- Pectin Issues
- Calandria Issues
- Pumping/Transferring Issues
- Volatilization of Aromas

Verdict: Practical in Some Applications

Whirlpool Addition

- Easy to Add
- Limited Contamination Risk
- Removal of “Fruit Trub”
- Pectin Issues
- Pumping & Transferring Issues
- Heat Exchanger Issues
- Mechanical Separation
  - Decanter
  - Centrifuge?
  - Filter
  - Settling

Verdict: Practical in Some Applications

Mashed Fruit?

- Significant Loss of Flavor
- Bad Bang for Buck
- Color Pickup
- No Real Benefit for Concentrate, Powder or Extract

Verdict: Not Most Practical
**Pre Heat Exchanger Bag Filter**

- Polyester Filter Bag
- Multiple Mesh Sizes: 10 – 800 micron
- Multiple Sizes 4” – 8” Diameter
- Stainless Steel Filter Housing

*(McMaster #s 9307T77, 9831SK66, Heights 13 & 14)*

---

**Fermenter**

- Volatilization (Primary Fermentation)
- Greatest Risk for Microbial Contamination
- Challenges Adding
- Flavor Extraction (Time)
- Secondary Fermentation
- Minimal Pectin
- Difficult Removal of “Fruit Trub”
- Maximum Flavor Pickup for Many Forms

*Verdict: Practical in Many Applications*

---

**Ways to Add Fruit**

- Open Fermenter or Large Top Access

*6” Port*
Ways to Add Fruit

- Secondary Vessel

Ways to Add Fruit

- Push in Puree/Concentrate/Liquid

Ways to Add Fruit

- Recirculation with Secondary “Dosing” Tank

Ways to Remove “Fruit Trub”

- Leave Behind
  - Racking Arm
  - Stand Pipe

- Removal
  - Filtration
  - Centrifuge
Long Term Aging

- In Tanks
- In Barrels
- Long Flavor Extraction
- Some Challenges Adding Fruit
- Settling of Pectins
- Microbial Contamination – May be Desired for Sour Beers

Verdict: Practical for Some Applications

At Packaging

- Need for Control
- Direct into BBT
  - Aroma Loss if Force Carbonating
- In line into Bottling/Kegging
- Challenge Adding

Verdict: Practical for Liquid and Maybe Powdered Extract

How Much Fruit To Add?

- Wide Variations Depending on Source

<table>
<thead>
<tr>
<th>Fruit</th>
<th>lbs/gal</th>
<th>lbs/bbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>0.5 - 3.0</td>
<td>15 - 30</td>
</tr>
<tr>
<td>Apricots</td>
<td>0.25 - 2.0</td>
<td>8 - 60</td>
</tr>
<tr>
<td>Blackberries</td>
<td>0.5 - 4.0</td>
<td>15 - 120</td>
</tr>
<tr>
<td>Blueberries</td>
<td>0.5 - 3.0</td>
<td>15 - 90</td>
</tr>
<tr>
<td>Cherries(Sour)</td>
<td>0.25 - 2.0</td>
<td>8 - 60</td>
</tr>
<tr>
<td>Cherries(Sweet)</td>
<td>0.33 - 4</td>
<td>10 - 120</td>
</tr>
<tr>
<td>Citrus</td>
<td>0.25 - 1.0</td>
<td>8 - 30</td>
</tr>
<tr>
<td>Currants</td>
<td>0.33 - 1.5</td>
<td>10 - 45</td>
</tr>
<tr>
<td>Peaches</td>
<td>0.5 - 5.0</td>
<td>15 - 150</td>
</tr>
<tr>
<td>Pears</td>
<td>0.5 - 2.0</td>
<td>15 - 60</td>
</tr>
<tr>
<td>Plums</td>
<td>0.5 - 2.0</td>
<td>15 - 60</td>
</tr>
<tr>
<td>Raspberries</td>
<td>0.25 - 2.0</td>
<td>8 - 60</td>
</tr>
</tbody>
</table>

Equivalencies

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Fresh</th>
<th>Puree</th>
<th>Concentrate</th>
<th>Dehydrated</th>
<th>Freeze Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apricots</td>
<td>1.00</td>
<td>0.80</td>
<td>0.20</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>Blackberries</td>
<td>1.00</td>
<td>0.90</td>
<td>0.15</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Blueberries</td>
<td>1.00</td>
<td>0.90</td>
<td>0.15</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>Cherries(Sour)</td>
<td>1.00</td>
<td>0.85</td>
<td>0.30</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Cherries(Sweet)</td>
<td>1.00</td>
<td>0.85</td>
<td>0.30</td>
<td>0.25</td>
<td>0.13</td>
</tr>
<tr>
<td>Citrus</td>
<td>1.00</td>
<td>0.85</td>
<td>0.15</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Currants</td>
<td>1.00</td>
<td>0.95</td>
<td>0.15</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Peaches</td>
<td>1.00</td>
<td>0.80</td>
<td>0.20</td>
<td>0.40</td>
<td>0.12</td>
</tr>
<tr>
<td>Plums</td>
<td>1.00</td>
<td>0.80</td>
<td>0.20</td>
<td>0.40</td>
<td>0.12</td>
</tr>
<tr>
<td>Raspberries</td>
<td>1.00</td>
<td>0.90</td>
<td>0.13</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Strawberries</td>
<td>1.00</td>
<td>0.90</td>
<td>0.15</td>
<td>0.25</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Fermentation Pilot Specs
- 92% 2-row, 8% Caramel 10
- 12 Plato S.G.
- 152 F Mash
- 15 IBU
- 60 min boil
- 1 mil cells/mL/P
- Fermented @ 70 F

Flavor Impact Studies
- 20 lbs per bbl (Equivalent Fruit Weight) Cherry(sweet) Puree added to Mash
  - No Perceivable Flavor Impact
  - Appreciable Color Pickup
- 10 & 20 lbs per bbl (EFW) Cherry(sweet) Puree added to Whirlpool
  - Perceivable Flavor Difference
  - Very Subtle Flavor Contribution
  - Specific Fruit Flavor Unidentifiable
- 5, 10 & 20 lbs per bbl (EFW) Cherry(sweet) Puree added to Fermenter after Primary Fermentation
  - 5 – No Real Flavor Perception (Slight Color)
  - 10 – Flavor/Color Perception Slight. No Identification of Cherry Flavor
  - 20 – Flavor/Color Perception. Split Identification of Cherry Flavor

Flavor Impact Studies
- Dosing in Cherry Extract to Light Lager
  - Recommended Rate: 0.35% - 0.65%
    - 0.35% - Strong Aroma, “Cherry Candy” Flavor
    - 0.65% - Overly Strong Aroma & Flavor
  - Acid addition (Phosphoric) at 0.025%
    - pH drop approximately 0.2
    - Improved Mouthfeel & “Brightness” of Flavor

  - Overall: Better Aroma w/ Extract, Flavor is Subjective

Yeast Health Impact Studies

Fruit Pilot Fermentation Plots

Control
Cherry
Orange

0 20 40 60 80 100 120 140
0 2 4 6 8 10 12 14
Gravity (P) ~ Time in Hours from Pitch
Microbial Impact

- All Fresh Fruit has Microbes on Surface
- Some Studies show 100s of Different 
- Small Scale Collection & Growth Project
  - Succeeded in Growing Bacteria & Yeast
  - Limited Translation to Beer
  - No Identification Yet
- Peracetic Acid Wash
  - 80 ppm wash
  - Interesting Results – Need More Experimentation

Sources of Fruit Products

<table>
<thead>
<tr>
<th>Company</th>
<th>Fruit Types</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Spice</td>
<td>Powder, Dehydrated</td>
<td><a href="http://www.americanspice.com">www.americanspice.com</a></td>
</tr>
<tr>
<td>Bare Fruit</td>
<td>Dehydrated</td>
<td><a href="http://www.barefruitsnacks.com">www.barefruitsnacks.com</a></td>
</tr>
<tr>
<td>Bella Viva Orchards</td>
<td>Dehydrated, Puree</td>
<td><a href="http://www.bellaviva.com">www.bellaviva.com</a></td>
</tr>
<tr>
<td>Bell Foods</td>
<td>Puree, Concentrate, Frozen</td>
<td><a href="http://www.bellfruits.com">www.bellfruits.com</a></td>
</tr>
<tr>
<td>Dennini Fruit Source</td>
<td>Powder</td>
<td><a href="http://www.dennickfruitsource.com">www.dennickfruitsource.com</a></td>
</tr>
<tr>
<td>Flavor's Bristol</td>
<td>Extract, Powder</td>
<td><a href="http://www.flavorsbristol.com">www.flavorsbristol.com</a></td>
</tr>
<tr>
<td>Fruit Fast</td>
<td>Concentrate</td>
<td><a href="http://www.fruitfast.com">www.fruitfast.com</a></td>
</tr>
<tr>
<td>International Associates</td>
<td>Juice, Concentrate, Puree</td>
<td><a href="http://www.internationalassociates.com">www.internationalassociates.com</a></td>
</tr>
<tr>
<td>Hill View Packing Co.</td>
<td>Juice, Concentrate</td>
<td><a href="http://www.hillviewpacking.com">www.hillviewpacking.com</a></td>
</tr>
<tr>
<td>Just Tomatoes</td>
<td>Freeze Dried</td>
<td><a href="http://www.justtomatoes.com">www.justtomatoes.com</a></td>
</tr>
<tr>
<td>Kanegrade</td>
<td>Concentrate, Puree</td>
<td><a href="http://www.kanegrade.com">www.kanegrade.com</a></td>
</tr>
<tr>
<td>Kerr Concentrates</td>
<td>Concentrate, Puree</td>
<td><a href="http://www.kerrconcentrates.com">www.kerrconcentrates.com</a></td>
</tr>
<tr>
<td>Mayan Sun</td>
<td>Powder</td>
<td><a href="http://www.mayafoods.com">www.mayafoods.com</a></td>
</tr>
<tr>
<td>North Bay, Trading Co.</td>
<td>Dehydrated</td>
<td><a href="http://www.northbaytrading.com">www.northbaytrading.com</a></td>
</tr>
<tr>
<td>Northwest Berry Growp</td>
<td>Puree, Concentrate</td>
<td><a href="http://www.nwberrycoop.com">www.nwberrycoop.com</a></td>
</tr>
<tr>
<td>Northwest Naturals</td>
<td>Concentrate, Puree</td>
<td><a href="http://www.nwnaturals.com">www.nwnaturals.com</a></td>
</tr>
<tr>
<td>Northwestern Extracts</td>
<td>Extract</td>
<td><a href="http://www.nwextract.com">www.nwextract.com</a></td>
</tr>
<tr>
<td>Oregon Fruit Puree</td>
<td>Puree, Concentrate</td>
<td><a href="http://www.oregonfruit.com">www.oregonfruit.com</a></td>
</tr>
<tr>
<td>Perfect Puree</td>
<td>Puree, Concentrate</td>
<td><a href="http://www.perfectpuree.com">www.perfectpuree.com</a></td>
</tr>
<tr>
<td>San Francisco Herbs Co.</td>
<td>Dehydrated, Powder</td>
<td><a href="http://www.sfherb.com">www.sfherb.com</a></td>
</tr>
<tr>
<td>Traverse Bay Farms</td>
<td>Concentrate, Dehydrated, Powder</td>
<td><a href="http://www.traversebayfarms.com">www.traversebayfarms.com</a></td>
</tr>
<tr>
<td>Vita-Pak Citrus</td>
<td>Puree, Juice, Frozen, Dehydrated</td>
<td><a href="http://www.vitapak.com">www.vitapak.com</a></td>
</tr>
<tr>
<td>Vita-Pak Citrus</td>
<td>Puree, Concentrate, Frozen</td>
<td><a href="http://www.vitapak.com">www.vitapak.com</a></td>
</tr>
<tr>
<td>Vita-Pak Citrus</td>
<td>Puree, Juice, Frozen, Dehydrated</td>
<td><a href="http://www.vitapak.com">www.vitapak.com</a></td>
</tr>
<tr>
<td>Vita-Pak Citrus</td>
<td>Puree, Concentrate, Frozen</td>
<td><a href="http://www.vitapak.com">www.vitapak.com</a></td>
</tr>
</tbody>
</table>

Flavor Impact Studies

- Raspberry Puree addition at 60 lbs per bbl (EFW) to Fermenter after Primary Fermentation (Brown Porter Base Beer)
  - Overpowering Flavor & Aroma
- Freeze Dried Apricot addition at 13 lbs per bbl (EFW) to Whirlpool (Wit Base Beer)
  - Perceivable Apricot Flavor & Aroma
  - Taste for Yourself
- Raspberry Extract (WONF) addition at 0.5% total Volume at Packaging (Strong Porter Base Beer)
  - Perceivable Raspberry Flavor & Aroma
  - Taste for Yourself

Questions???

kwright@hangar24brewery.com
Bibliography


Image Credits

- Image 1: http://www.nicolaiswallner.com/how-to-treat-skin-healthy-fruit.html
- Image 4: http://www.cookiesandwine.com/blog/tag/wine/
- Image 8: http://www.backpackingchef.com/dehydrating-fruit.html
- Image 11: http://www.mymanu.net/products.html
- Image 13 & 14: www.mcmaster.com