Hops are the flowers of the Humulus lupulus plant and are the balancing agent to the sweetness of malt. Qualities of hops include bitterness, aroma, and flavoring properties. Unboiled hops are only mildly bitter. There are two main types of hops, bittering and aroma. Some flowers from hops might be: grassy, floral, citrus, lemon, grapefruit, earthy, piney, and fruity. During the brewing process, hops are isomerized into alpha and beta acids. The alpha acids are responsible for most of the beer’s bitterness. The degree of bitterness in a beer is controlled by the degree to which alpha acids are isomerized during the boil. Beta acids are mostly used for aroma contributions. Hops can come in three types:

- **Fresh Hops**: whole cone hops that have been recently harvested (up to a week)
- **Dried Hops**: whole cone hops that have been dried to preserve oils and resin (most popular in craft beers)
- **Pellet Hops**: crushed, concentrated hop flowers that have been formed into pellets (most commercially used)

### Specific Hop Examples

**Cascade**
- Developed by Jack Homer and his team at Oregon State University. Ever since the development Cascade hops have become one of America’s most popular hops. Currently represents 10% of all hops grown in the US. Cascade was originally developed through open pollination of English variety Fuggle and the Russian variety Serebrovanka and is named after the Cascade Range, mountains that run from northern California all the way north to British Columbia, Canada (“Cascade (US),” 2018).
- **Beer Styles**: American Pale Ale, IPA
- **Aroma Notes**: Grapefruit, Floral, Pine
- **Alpha Acids**: 5.5-9%
- **Beta Acids**: 4-6.75%
- **Country of Origin**: United States

**Fuggle**
- The Fuggle hops originate in England and was first discovered in 1861 in a hop yard owned by George Stace in Kent. Some 14 years later it was officially named and introduced by Richard Fuggle of Bendeleigh in 1875. Similar to a Styrian Golding, it is noted for its distinct European aroma and has enjoyed a long, versatile run. At its peak nearly 100 years ago Fuggle was known as a dual-hop variety. Today however, as other higher alpha variety hops have become more prevalent, it’s now more prominently used for its aroma (“Hop Varieties,” 2019).
- **Beer Styles**: English Style Bitter, Stout, Brown Ale, Porter, Pale Ale
- **Aroma Notes**: Green tea, mint, grass, floral
- **Alpha Acids**: 3.5-8%
- **Beta Acids**: 2-3%
- **Country of Origin**: United Kingdom

**Mosaic**
- Developed by Hop Breeding Company in 2012, has high alpha acids and a wide variety of flavors and aromas (hence the term “Mosaic”). Derived from a cross of a female Simcoe and male Nugget hop. Very fruity
- **Beer Styles**: IPA, Pale Ales, Stouts
- **Aroma Notes**: Blueberry, Tangerine, Papaya, Rose, Blossom, Bubble Gum
- **Alpha Acids**: 10.5-14%
- **Beta Acids**: 3-4.5%
- **Country of Origin**: United States

### Anatomy of a Hop

- **Strig**: Is a long stalk that connects the bracteoles to the bine
- **Bracteoles**: Are leaf-like structures that are connected to the main stem
- **Lupulin glands**: These are what you are really seeking in hops. They are small yellow sacs that contain many chemicals including the essential oils, alpha acids, and beta acids that everyone is immuscular.

### Isomerization

- **β-acids**: Bittering agents
- **α-acids**: Aromatics
- **essential oils**: A blend of aromatic compounds that contribute to the hop’s flavor and aroma

### Conclusions

Based on the research completed, a diagram was created after categorizing the hops varieties on their flavor and aroma profiles to allow for a visual understanding of their characteristics and how they can be used interchangeably.

### Acknowledgements

Special thanks to the Chemistry Department and faculty Dr. Edward Liss; Dr. Andrew Callender’s; and Dr. Derek J. Cashman for their knowledge.

Special thanks to the QEP Grant for making this research possible.

### References