Third Edition

BARTH-HAAS HOPS COMPANION

A brewer's guide to hop varieties and hop products

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Barth-Haas Hops Companion

A Guide to the Varieties of Hops
and Hop Products

Third Edition

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Barth-Haas Hops Companion

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PREFACE

The Barth-Haas Hops Companion has evolved through this, its third edition, and our aim is to provide a convenient guide to hops and hop products as well as a comprehensive listing of varieties generally available worldwide. The number of varieties listed has grown from 81 entries in our first edition to 146 only seven years later. However, not all of these additions are new commercial cultivars, as some have been brought back from retirement – finding new life in today's expansive brewing environment.

A question we occasionally get regarding our variety listings is why no recommended substitutions are given, which of course would be very helpful when replacements are needed. The simple answer is: it's not so simple anymore! In years past, hop varieties were often developed with the goal of closely replicating already popular hops, often to provide enhanced disease resistance and yield, or perhaps extending a variety-type to a different growing region.

A major objective now for releasing new varieties is to satisfy brewers' demands for uniqueness and boldness. Hops are no longer just a subtlety of beer, and single hop varieties can now establish a beer's identity - its trademark. The personalities of varieties such as Citra®, Simcoe®, Mosaic®, Galaxy™ and Nelson Savin™ just have no reasonable substitutes, so we've chosen not to do the injustice of attempting to get close with a list of "similar" hops. We would rather you talk with us if you

need a recommendation. Contact Haas or any of the Barth-Haas Group affiliates and we will work with you and your particular situation to provide the best options.

Also evolving in the Hops Companion is its practical brewing side, describing hops and hop product applications and best practices. Now included in this edition is a guide for the use of CO2 Pure Resin Hop Extract, recently gaining favor with craft brewers as a way to provide more efficient hop bitterness and reduce beer losses resulting from high-dose hopping.

The variety descriptions and data presented here in the Hops Companion is a compilation derived from a number of sources, and therefore recognition and appreciation are given to those organizations from which the information is drawn. The list is long, so it is provided separately on page 29.

As with the two previous editions of this book, Dr. Christina Schönberger of Barth Innovations Ltd has provided her artwork for the title page. Thank you Christina for adding some creative flair to the publication.

Finally, in this edition of the Hops Companion you will no doubt notice the use of the country name *Czechia*, which is a short-form identity just recently and officially adopted by the Czech Republic. As always, we strive to be on the leading edge.

Tim Kostelecky
John I. Haas, Inc.
Yakima, Washington USA

INTRODUCTION

HOPS AND HOP PRODUCTS

Hops have been used since medieval times as an essential ingredient of beer. They are a primary contributor to beer flavor and aroma and as such are often called the "spice of beer". Hops also act as a preservative for beer and as a primary building block of beer foam.

The hop plant is a perennial climbing vine that can be female or male. The hops used in brewing are the cones from the female hop plant, which are often erroneously referred to as flowers but are actually fruiting bodies technically known as strobiles. The hop cones contain the substances that are of value in brewing, mainly, the hop resins, which are contained in organelles called lupulin glands. Male plants are used in hop breeding but have no use in the brewing of beer.

The primary hop resin components are the alpha acids, beta acids, and essential oils. The alpha acids are the most important hop resin components and are converted in the brewing process to isoalpha acids, which are the primary bittering components of beer. The beta acids are a second major component of hop resin but do not contribute to beer bitterness in their original form, but may contribute to beer bitterness when oxidized. The hop essential oils are a complex mixture of volatile compounds that contribute to beer flavor and aroma.

Although all hop varieties can provide both bitterness and aroma, they are usually classified as either aroma hops or bitter hops. The aroma hops, which are typified by low alpha acids content and an essential oil profile associated with good aroma, would generally be used as finishing or conditioning hops. Bitter hops have a much higher level of alpha acids and are generally added early in the kettle boil to more efficiently extract bitterness. Some hop varieties are considered "dual purpose" and thus can act as both aroma and bitter hops.

Hops may be used in brewing in many forms. The simplest form is known by a number of different names which include whole hops, raw hops, cone hops, leaf hops or baled hops. A vast array of other hop products is available, all produced from whole hops by specialized technologies and used for numerous applications in various ways.

In brewing, hops and hops products are generally classified into three categories, namely "kettle products", "post

fermentation products" and "dry-hopping products. For dry-hopping, i.e. hops added directly to fermented beer, the "kettle" products of whole hops or pellet hops are typically used.

KETTLE PRODUCTS

WHOLE HOPS

Whole hops are the simplest form of hops. Also commonly called leaf hops or baled hops, they are produced on the farm from harvested fresh hop cones that have been dried and baled. Whole hops have a number of disadvantages compared to other hop products, including that they are perishable and bulky, thus expensive to store, ship and handle, and they are not homogeneous, making sampling and bitterness control challenging. They also provide poorer utilization than other hop products and require special brewhouse

equipment. Nevertheless, whole hops are still used by some brewers because they believe that switching to pellets or other processed products would cause an undesirable flavor change in their beer or that whole hops are more natural and traditional, and that these advantages outweigh the disadvantages.

HOP PELLETS

In the brewhouse, hop pellets are used much the same way as whole hops. However, due to the pelleting and packaging process, hop pellets are much more homogenous and stable than whole hops. Descriptions of various pellet products are further described in the following text.

When using pellets, the required dosage is weighed and then added to the kettle on a schedule prescribed by the brewer. Automated dosing systems are available that make the use of bulk hop pellets possible and advantageous. The pellets readily disintegrate to a powder in the boiling wort releasing the hop acids into the wort. Once wort boiling is complete, spent hop material is typically removed along with the trub in the hot wort whirlpool tank. Simple settling in a hot wort tank, or centrifuging, may also be used. Hop pellets are also commonly used for dry-hopping into fermented beer.

Hop Pellets - Type 90

Type 90 hop pellets (also called regular or T90 hop pellets) are produced by breaking up the hop bales, separating any extraneous material, milling in a hammer mill, passing the powder through a pellet mill and packaging the pellets either under vacuum or in an inert atmosphere. T90 pellets were originally named as such because they once contained approximately 90% of the non-resinous components (e.g. moisture, cellulose, protein, etc.) found in the hop cones.

Type 90 pellets are added to the kettle to provide hop bitterness and hop aroma character. They can also be used for dry hopping. T90 pellets provide improved homogeneity, better storage stability and reduced storage/transport costs compared to cone hops. Generally, their effect on beer flavor is indistinguishable from that produced from the original cone hops.

Hop Pellets - Type 45

Enriched hop pellets (also called Type 45 or concentrated hop pellets) are a kettle-added hop product providing bitterness and hop character. The hop bitter acids and

hop oils are concentrated mechanically by removing much of the fibrous vegetative portion of the cone and thereby enriching the lupulin. Type 45 (T45) pellets were named as such because, through this enrichment, they historically contained about 45% of the non-resinous components (e.g. moisture, cellulose, protein, etc.) found in the hop cones from which they were produced.

T45 pellets can be used for dry hopping, and like Type 90 hop pellets, they provide improved homogeneity, better storage stability, and reduced storage/transport costs compared to raw hops. Also like T90 pellets, beer produced from T45 pellets is typically indistinguishable from beer produced from the original hop cone material.

Isomerized Hop Pellets

Isomerized Hop Pellets (isopellets) can often serve as a replacement for conventional alpha acid kettle products, namely hops, pellets or extract, with the benefit of providing improved bitterness utilization. Isopellets are produced by mixing hop powder with a small amount of magnesium oxide, pelletizing the mixture, packaging and sealing the pellets in vacuum as for normal pellets, and finally warming these packaged pellets to approximately 50°C for one to two weeks.

The alpha acids are converted to their magnesium salts due to the magnesium oxide addition, and are almost completely isomerized under the warm storage, with a

consequent significant increase in bitterness utilization. Due to this higher utilization, isopellets provide opportunities for considerable savings in hop cost (e.g. often twice the utilization of T90 or T45 pellets). However, a brewer should not automatically assume that isopellets can be used as a direct substitute of regular pellets since the sensory characteristics of the hop oils in isopellets can be influenced during the two week heating step. Flavor trials are recommended before transitioning to this product.

CO2 HOP EXTRACTS

Hop extracts are produced by extracting oleoresin material found in the hop lupulin glands, and as such, hop extract often retains the aroma and the bittering potential of the hops from which it is made. With its excellent stability, hop extract is a convenient and concentrated alternative to raw hops or hop pellets. Production of hop extracts, and some popular extract products are described below.

The dominant solvent used worldwide for extraction of hops is carbon dioxide (CO_2), primarily as a supercritical fluid and to a

lesser extent in the liquid state. With either supercritical or liquid CO_2 extraction methods, all the hop resin components of interest to the brewer are extracted from the original hops. However, unlike supercritical extract, the liquid CO_2 process does not extract chlorophyll and other pigments. Thus the liquid CO_2 product is golden yellow compared with the supercritical product, which is typically dark green. This color difference has no consequence in brewing.

CO_2 hop extract contains the alpha acids, beta acids, essential oils, and other soft resin components of hops. The extract may be marketed as the undiluted resin (usually called pure resin extract) with an alpha acids content from 30% to 65%, depending on the characteristics of the original hops. Also, the resin may be standardized to a designated alpha acids content using corn syrup or other plant syrup as a diluent. In the past, standardized hop extract was a very popular product, but has gradually been supplanted by pure resin extract.

CO_2 hop extracts have many advantages over other kettle products. These are:

1. They are the most stable form of hop product. Pure resin extracts can be stored for several years at ambient temperature with negligible loss of brewing value.

2. Utilization of hop extracts in the kettle is better than with other traditional types of kettle hops.

3. Hop extracts are extremely uniform. The alpha acids content is carefully adjusted to customer specifications at the processing plant for optimum consistency.

4. Shipping, storage weight and volume are substantially reduced as only the extract material (typically 20-25% of the original hop material for high alpha hops) is retained and packaged.

There are many successful designs for CO2 extract dosing, but there are many points to take into consideration for optimal product performance and utilization. A properly designed dosing system will ensure trouble-free performance of the product and provide a high level of product utilization and consistency in the final beer product. We highly recommend that the brewer take appropriate measures to provide a high quality and precise dosing system that will ultimately repay a return on investment in optimum product utilization and performance.

Depending on the size of the brew and the sophistication desired, there are a number of methods that can be utilized for dosing CO2 hop extract into the brew.

1. Manually dosing full or partial cans or pails of extract directly into the kettle or wort grant
2. Suspending cans of extract individually or in a metal cage in the kettle

3. External dosing units using cans or a measured quantity of extract
4. Sophisticated systems for handling automated dosing of cans or drums of extract

When using extract in cans, a common procedure is to perforate the can top and bottom with several holes (3/4 in. or 15 to 20 mm) and suspend the can in the brew kettle above or just below the surface of the boiling wort. Alternatively, the top of the can may be removed and the open can placed under a tap in the grant during wort run-off. Another procedure is to liquefy the extract by placing the can in hot water, then pour the extract slowly into the boiling wort.

If cans are suspended in the kettle, it is recommended that a container no larger than 4-kilos be used since the time for the can to empty increased with the larger can size and the subsequent boiling time for dispersion and isomerization of alpha acids may be reduced, resulting in lower bittering yield.

Many brewers will utilize automated methods for hop extract dosing which range from sophisticated external

devices designed for circulating wort from the kettle through chambers holding cans to heated, enclosed chambers that will heat 200kg drums of extract prior to directly pumping or transferring hop extract into dosing vessels. Confer with dosing equipment suppliers regarding their recommendations for your specific needs.

Larger production scale CO2 Extract dosing systems.

Photos provided by Decker Machinenbau - Germany

Any of these dosing procedures will give satisfactory results, but it is recommended that the brewer consult with a Haas sales or technical representative to determine the method that is most applicable for your brewery's specific set up.

CO2 Extract Dosing Calculations

Conditions in different breweries vary so widely that no single formula is adequate for all breweries. From information provided by the brewer on hoping rate, type of hops used, and hop boiling schedule, a recommended initial dosage rate will be provided by Haas sales or technical personnel.

When replacing hop pellets with extract, it is usually recommended that the alpha acids kettle dosage be reduced by 10 to 20% (typically alpha utilization is increased by about 5% absolute, e.g. 25 to 30).

The basic calculation for hop dosing:

Kg product to dose = (hL X ppm) / (%U X %conc)

- hL = Final beer volume in hectoliters (1 bbl = 1.174 hL)
- ppm = ppm isoalpha acids desired in final beer; roughly relates to bitterness units
- %U = Estimated percent utilization = (isoalpha acids in beer / alpha acids dosed) X 100

- %conc = Percent concentration of alpha acids in hop product

Example: 100 bbl finished beer, 40 ppm IAA desired, 30% utilization, 45% alpha acids in extract

((100 X 1.174) X 40) / (30 X 45) = 4696 / 1350 = 3.48 kg **extract** to dose

Often, brewers choose to dose extract based on alpha content, particularly if standardized extract is used, e.g. extract can is filled with a specific grams of alpha (GMA). In this case, the %conc value should be entered as 100. Using the example above, modify with:

((100 X1.174) X 40) / (30 X **100**) = 1.56 kg or 1,560 grams **alpha** to dose (or fill into a standardized can of extract).

The size of can used for a standardized addition depends on the total alpha for it to contain and the percent alpha in the extract. In the above example, the dosage requires 1.56 kg alpha residing in 3.48 kg of extract (1.56 / 45%). The brewer can choose the number and size of cans to have a standard fill per dose.

- One 4 kg size can with 3.48 kg extract; containing 1.56 kg alpha per can, or
- Two 2 kg size cans with 1.74 kg extract each; containing 780 grams alpha per can, or

- Four 1 kg size cans with 870 grams extract each; containing 390 grams alpha per can

CO2 Extract - Cleaning and Sanitation

Because of the tendency for hop acid resins to stick to surfaces and build up, it is recommended that periodic cleaning be performed on any permanent dosing system. A cleaning procedure will usually be included in the operating instructions for commercial dosing units, and we recommend that those instructions be meticulously followed. For general periodic cleaning and maintenance, the system can be flushed with a caustic solution at a strength that is typically used for CIP cleaning, and can be performed during the scheduled CIP cleaning of the brew system.

An advantage with smaller, less sophisticated systems such as external hop dosing units utilizing circulating wort, perforated cans suspended in the kettle, or manual dosing from a package, is that cleaning is simplified with no routine cleaning and maintenance required. However, there's always a chance that hop extract will be spilled externally on equipment, flooring, clothing, and skin. It is recommended that personal protective equipment be worn when handling hop extract including safety glasses, rubber or plastic disposable gloves and protective clothing. Hop resin is not particularly hazardous but can be an irritant and difficult to clean using standard soap or detergents and water.

Alcohol solutions such as 50% ethanol, 50% methanol, or 70% isopropanol work well for cleaning spills, but be aware that these are volatile solvents and appropriate caution should be taken when handling. For any cleaning that has exposure to the wort or beer steam, ethanol is preferred. An alternative to ethanol is the use of a dilute potassium hydroxide solution (approx. 0.1 molar) for cleaning equipment. If using a caustic solution, it is important to follow with a generous flush of distilled or deionized water.

ISOMERIZED KETTLE EXTRACT (IKE)

Isomerized kettle extract (IKE) is produced by heating pure resin CO_2 extract with magnesium catalyst (e.g. magnesium carbonate) under controlled conditions, which converts the alpha acids to isoalpha acids with a greater than 95% transformation.

The isoalpha acids in IKE are in their free-acid form and, along with its full complement of hop oils, IKE can be used as an acceptable alternative to hops, pellets or CO_2 extract in the kettle. All brewing properties are similar to conventional CO_2 extract but the utilization of isoalpha acids is significantly higher. As with the caution given with isopellets, the hop oils in IKE may be modified from their original form by the isomerization process, and flavor trials are recommended.

POST-FERMENTATION PRODUCTS

POST-FERMENTATION AROMA PRODUCTS

Hop Oil

The Barth-Haas Group provides a range of molecular distilled and steam distilled hop oils in their pure form that are variety-specific and therefore retain characteristics of individual varieties. In their pure form, hop oils are not readily dispersible in beer, and therefore need to be mixed with an emulsifier or a carrier such as ethanol, especially if the hop oils are to be added to finished beer. One part Pure Hop Oil with five parts ethanol is often used for dry-hopping with a typical dosage rate of 1 to 2 ppm oil per hectoliter prior to final beer filtration.

Various methods are available for addition of these hydrophobic oils to beer including injection of the products dissolved in liquid CO_2 into the beer stream, and adding the oils as ethanol solutions to the beer stream. They may be added to beer either pre- or post-fermentation.

PHA® - Pure Hop Aroma

The Barth-Haas Group offers a series of advanced hop aroma products known as PHA® Hop Flavors produced by Barth-Haas UK, specifically formulated to provide both kettle-hop and dry-hop aromas in beer in a con-

sistent and easily dosed form. These hop aroma products are prepared from hops by proprietary technology, including specific extraction and distillation methods. PHA® is completely water-soluble and light-stable, and can be added post-fermentation.

The standard PHA® products are designed to provide late-kettle hop aroma to beer and are available from named varieties, including Saaz, Hersbrucker, Goldings, Cascade, Styrian and others. They also come in "Classic" aroma forms that give specific beer flavor attributes including citrus, floral, herbal, spicy and sylvan.

In addition, a variety specific series of PHA® has been developed called PHA Topnotes. These are designed to provide an efficient, effective, and flexible means for adding dry-hopping aroma to beer, consistently, with immediate flavor impact using simple, direct dosing into finished beer.

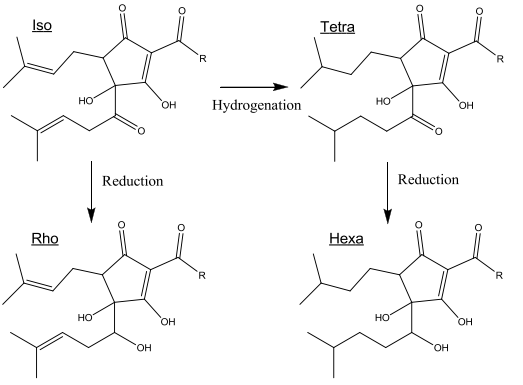
The PHA® products have many advantages. Unlike pure hop oil, PHA products are 100% dispersible in aqueous solutions (like beer or other beverages) and they offer an alternative means of adding consistent hop aroma independent of typical product or process variables including annual crop variations. Besides providing their own very pleasant late-hop and dry-hop character to the beer, PHA® can enhance other existing flavors in the beer, and can help to mask off-flavors.

Additional information on these and other products is available through a Barth-Haas Group representative, or by visiting www.barthhaasgroup.com.

POST-FERMENTATION BITTERING PRODUCTS

The Barth-Haas Group produces post fermentation bittering products from CO_2 hop extract using an all aqueous process to separate isomerized alpha acids from other hop extract components. The Barth-Haas Group calls its isomerized alpha acids product, Isohop®.

Also available are three common reduced isomerized hop extract products called rho- (or dihydro-), tetrahydro- and hexahydro-isoalpha acids. The Barth Haas Group calls their reduced isomerized alpha acids products Redihop®, Tetrahop Gold®, Hexahop Gold®, and Hexahop 95®. The structures of the various isomerized and/or reduced alpha acids are shown below.



Structures of isomerized, reduced alpha acids

Isohop® is an aqueous alkaline solution of the potassium salts of isoalpha acids standardized to 30% w/w isoalpha acids by HPLC. Isoalpha acids are the native bittering acids that are found in traditionally hopped beer. Isohop® is used to replace bittering hops for utilization or economic reasons and to adjust bitterness in beers that were under-hopped in the kettle. For precise control of beer bitterness, Isohop® should be added post-fermentation to adjust the bitterness of the beer to the target bitterness units (BU). It may also provide an economic alternative to kettle hopping when practicing high gravity brewing. Isohop® contributes to foam stand and cling in the same way that traditional bitter hopping does (e.g. with cone hops, pellets, or CO_2 extract). Isohop® will also act as a natural antimicrobial agent when added to beer and provides very good utilization along with comparatively low costs.

Redihop® is an aqueous alkaline solution of the potassium salts of rho-isoalpha acids (rho) standardized to 30% w/w rho-isoalpha acids by HPLC. It is produced from alpha acids derived from CO_2 extract that have been extracted, isomerized, and then reduced using sodium borohydride. Redihop® gives protection from light-struck flavor when used as a sole source of hop-derived bittering or in conjunction with other reduced hop products. Furthermore, when added to wort or beer, Redihop® will act as an antimicrobial agent. Redihop® is often described as having a pleasant, smooth bitterness.

Tetrahop Gold® is an aqueous alkaline solution of the potassium salts of tetrahydro-isoalpha acids standardized to 9% w/w tetrahydro-isoalpha acids by HPLC. It is produced from alpha acids derived from CO_2 extract that have been extracted, isomerized, and then reduced using a palladium catalyst. Tetrahop Gold® enhances beer foam when used as a post-fermentation replacement for part of the normal bittering. In the absence of alpha acids and isoalpha acids, Tetrahop Gold® will give protection from the formation of light-struck flavor. Furthermore, it will act as an antimicrobial agent when added to beer.

Hexahop Gold® is the Barth-Haas Group trade name for a 50:50 combination of hexahydro-isoalpha acids and tetrahydro-isoalpha acids. It is an aqueous alkaline solution of hexahydro-isoalpha acids and tetrahydro-isoalpha acids standardized to 10% w/w by HPLC. It is produced from alpha acids derived from CO_2 extract that have been extracted, isomerized, and then reduced using palladium catalyst and further reduced with sodium borohydride to achieve a 50% hexahydro-isoalpha acids concentration. Hexahop Gold® is a clean-tasting hop extract that improves foam stand and cling and can be used for light-stable hopping in beers that will be packaged in green or clear glass and imparts pleasant, smooth bitterness. Hexahop Gold® is especially effective when used to improve or develop low BU beers. Hexahop Gold® will also act as an antimicrobial agent when added to beer.

Hexahop 95® (95:05 Hexahydro-isoalpha acids: Tetrahydro-isoalpha acids hop extract). Hexahop 95® is the Barth-Haas Group trade name for a 95:05 combination of hexahydro-isoalpha acids and tetrahydro-isoalpha acids. It is an aqueous alkaline solution standardized to 20% w/w by HPLC. It is produced from alpha acids derived from CO_2 extract that have been extracted, isomerized, and then reduced using palladium catalyst and further reduced using sodium borohydride to achieve a 95% hexahydro-isoalpha acids concentration. Hexahop 95® is a very clean-tasting hop extract that improves foam stand and cling and can be used for light-stable hopping in beers that will be packaged in green or clear glass bottles. Hexahop 95® is especially effective when used to improve or develop low BU beers. It will also act as an antimicrobial agent when added to beer and imparts a pleasant, smooth bitterness.

GUIDE TO HOP VARIETY DATA SHEETS

The remainder of this booklet is devoted to the description of many of the hop varieties that are commercially available worldwide. Included in the hop variety data sheets is information pertaining to hop quality and agronomic performance.

The analytical data ranges presented in this booklet are typical values for a particular variety and are not meant to encompass all values which may be observed. The ranges refer to freshly harvested hops grown and prepared under normally accepted conditions. Analytical results for whole (baled) hops which have been stored for several months may be outside the defined ranges, especially for varieties which are known to have poor storage characteristics.

A description of terms used in the variety data sheets can be found in the following text.

Hop Type

Aroma, Bitter, High Alpha, Dual Purpose

Hop varieties have classically been characterized and bred as two different types: Aroma hops and bitter hops. Through the breeding selection process, the aroma and chemical characteristics among these two types had

historically become increasingly disparate and differentiating them was relatively simple.

Bitter Hops have been typically classified to be high in alpha acids (above 6 percent was considered high decades ago), with a moderate to high cohumulone content and little regard to the aroma quality since these hops were generally added early in the kettle boil.

Aroma Hops were carefully selected for their distinctive aroma quality, often low cohumulone and a characteristic ratio of the major essential oils such as humulene, caryophyllene and farnesene. Alpha acids were typically low – below 5 percent.

As the breeding selection of higher alpha acids in the bitter varieties were made, a significant increase in the concentration of bitter acids occurred in the newer varieties, progressing from the six to ten percent range up to 13 to 20 percent. Because of the significant difference in the bittering potential of a six percent hop and those at 13 percent and above, another hop classification was developed – "**High Alpha Hops**" – generally considered as bitter varieties containing higher than 13 percent alpha acids.

In some hop breeding lines, a crossover effect of higher alpha acids and fine aroma contributions occurred, and therefore a new characterization beyond aroma and bitter hops was established, and that is the "**Dual-Purpose**" hop, which are well suited for aroma contribution, but are

also good contributors to beer bitterness with their high alpha content.

Recently, a new classification of hop is emerging as a result primarily of the craft brewing industry and its appetite for high hop impact in their beers. This has led to the commercial development of hop varieties with bold, atypical aromas, often exhibiting "non-classic" hop aromas such as high citrus, fruity and even tropical fruity. These hops are favored for their high impact on the flavor of the beers produced. Again, because of the significant differentiation of these hops from the classic aroma-hop types, and also given that the alpha content can be widely varied, a new category has arisen which we at the Barth-Haas Group refer to as "**Flavor Hops**".

The Flavor Hops category is highly subjective in its determination of imparting a significant and bold impact on the beer produced. Because the potential confusion and debate in assigning varieties as flavor hops, the Hops Companion will refrain from using the Flavor Hop classification until we properly evaluate the wide range of hop varieties and assign the classifications accordingly.

Pedigree

These are brief remarks about the ancestry of a variety. In the case of very old varieties like Saaz or Hallertau, there is no ancestral information. We know only that this particular varietal type was selected over many years by

growers and brewers in that particular area. More modern varieties can often be traced back through two to three generations of crosses often involving other known hop varieties. It is important to note that the qualities of a hop variety are only partly determined by the genes it receives. Of at least equal importance is the selection for particular characteristics practiced by the hop breeders.

Aroma

Much is spoken of the organoleptic quality and intensity of dried hop aroma. These are again strong varietal characteristics and there does appear to be a general relationship between the type and heaviness of a hop aroma and the flavor and aromatic properties of a resultant beer. However, this relationship can be obscured by the manner of using the hops. A skilled, comparative aromatic evaluation of samples of one variety can detect those samples which have been picked too early or too late, or over dried. Moreover, a trained evaluation can select particularly favorable lots of a variety from within the normal range of aroma exhibited by that variety in a particular season.

For more information regarding hop aroma contribution to beer and specific aroma characterizations of many of the world's hop varieties, an excellent resource is *The Hop Aroma Compendium – A Flavour Guide*, published by Joh. Barth & Sohn GmbH - available at www.barthhaasgroup.com.

Alpha Acids

These are the major component of the soft resins. When isomerized, these materials provide the main bitter compounds associated with beer. The alpha acids content varies widely among hop varieties from levels of 3-4% w/w in aroma type hops to levels of 13-16% and higher in the bitter hops and also in the flavor hop classification.

Beta Acids

Another soft resin component, the beta acids, are not well soluble in wort and beer and are generally not an influence in brewing. Beta acids are not bitter in the original form, but the oxidation of beta acids produces hulupones that are soluble and do contribute to beer bitterness. This was more of an issue in years past when whole hops were commonly used.

Cohumulone

The alpha acids exist in three analogous forms, humulone, adhumulone and cohumulone; and the proportions of these analogues vary markedly with variety. It is believed by some that relatively high levels of cohumulone produce a harsh, unpleasant bitterness and have a negative impact on head retention. This belief is now questioned, but varieties with relatively low cohumulone levels are still favored by some brewers.

Total Oil

Hop oil content generally ranges from 0.5 to about 4 mL per 100 grams of hops and can vary widely among seasons, varieties, and growing locations. The quantity and composition of the essential oils are responsible for the amount and quality of hop flavor and aroma in beer. A brewer, when deciding on which varieties and how much to use will always consider the hops' contribution to flavor and aroma as well as its bittering potential.

Myrcene, Humulene, Caryophyllene and Farnesene

These are four major components of the essential oils and between them they account for about 60-80% of the essential oil of most varieties. The amount of these constituents, and particularly the ratios between them, can be used as clear varietal characteristics. These compounds are all highly volatile hydrocarbons and during boiling of the wort, most if not all of them are driven off and so contribute little to hop flavor and aroma in beer. Some of the oxidation products of these compounds, such as the humulene epoxides, are thought to be positive contributors to beer flavors and hence sufficient aging of aromatic hop varieties is necessary to allow these products to be formed.

Storage Stability

Oxidation of alpha acids removes their ability to be isomerized to the required bitter isomers. In comparable circumstances some varieties lose a greater proportion of their alpha acids to oxidation than do others. Cold storage and anaerobic conditions can both delay oxidation, but the innate property of a variety in this context is important to commerce. Interestingly, some oxidation of essential oil components is necessary to produce compounds thought to be important in beer flavors so controlled aging is important for hops required for both bittering and aromatic properties.

HOP VARIETY DATA SOURCES

American Dwarf Hop Association, Moxee WA USA

Assoc. of German Hops Growers, Wolnzach Germany

British Hop Association, Kent England

CLS Farms, Moxee WA USA

Comptoir Agricole Breeding Program, Strasbourg France

Hop Breeding Company, Yakima WA USA

Hop Growers of America, Moxee WA USA

Hop Products Australia, Hobart Australia

Hop Research Institute, Co., Ltd., Žatec Czechia

Institute of Biotechnology – Agriculture & Food, Warsaw Poland

Joh. Barth & Sohn GmbH & Co. KG, Nuremberg Germany

John I. Haas, Inc., Yakima WA USA

New Zealand Hops Limited, Nelson New Zealand

Select Botanicals Group LLC, Yakima WA USA

S.S. Steiner, Inc., New York USA

USDA Agricultural Research Service, USA

Yakima Chief – Hopunion LLC, Yakima WA USA

Hop Varieties - Listed By Country of Origin

Kazbek	Aroma	93
Premiant	Aroma	130
Rubin	Bitter	135
Saaz	Aroma	136
Saaz Late	Aroma	137
Sládek	Aroma	141
Vital	Multi-Purpose	175
France		
Aramis	Aroma	43
Mistral	Aroma	106
Strisselspalt	Aroma	154
Triskel	Aroma	170
Germany		
Hallertau Blanc	Aroma	83
Hallertau Mittelfrueh	Aroma	84
Herkules	High Alpha	87
Hersbrucker	Aroma	88
Hüll Melon	Aroma	90
Magnum	High Alpha	100
Mandarina Bavaria	Aroma	101
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Hops Variety Data Pages

Arranged Alphabetically by Variety Name

Admiral

U.K.

High Alpha Hop

Bred at Wye to complement the variety Target, this variety matures about one week earlier and yields considerably better in terms of alpha acid per hectare. It grows vigorously, producing small compact cones, which pick well on the machine. Its tolerance to wilt is similar to Progress but the storage stability of its alpha is better than Target.

Pedigree	Cross of Challenger & Northdown
Aroma/Flavor	Typical British Aroma
Alpha Acids*	13.0 - 16.0 %
Beta Acids	4 - 6 %
Cohumulone	37 - 45 % of alpha acids
Total Oil	1.0 - 1.7 ml/100g
Myrcene	39 - 48 % of total oil
Humulene	23 - 26 % of total oil
Caryophyllene	6 - 8 % of total oil
Farnesene	1 - 3 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Agnus

Czechia

Dual Purpose Hop

The Agnus name derives from the Czech hop breeder Beránek, which means Angus in Latin. Released in 2001, it is characterized by relatively high beta acids for a higher alpha variety. It has good quality characteristics for use in Czech-type pilsners.

Pedigree	Hybrid progenies of Bor, Sládek, Saaz, Northern Brewer and Fuggle
Aroma/Flavor	Robust spicy
Alpha Acids*	9.0 - 12.0 %
Beta Acids	4.0 - 6.5 %
Cohumulone	29 - 38 % of alpha acids
Total Oil	2.0 - 3.0 ml/100g
Myrcene	40 - 55 % of total oil
Humulene	15 - 25 % of total oil
Caryophyllene	8 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Ahtanum™

U.S.
Aroma Hop

Ahtanum is a cultivar named after the district in which it is grown near Yakima. Ahtanum™ was developed through the Yakima Chief Ranches breeding program and has an appealing aroma with exceptionally floral notes. It is used for its aromatic properties and moderate bittering.

Pedigree	Open Pollination
Aroma/Flavor	Citrus, floral, earthy
Alpha Acids*	3.5 - 6.5 %
Beta Acids	4.0 - 6.0 %
Cohumulone	30 - 35 % of alpha acids
Total Oil	0.5 - 1.7 ml/100g
Myrcene	45 - 55 % of total oil
Humulene	16 - 22 % of total oil
Caryophyllene	9 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair to Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Amarillo®

U.S.
Aroma Hop

Amarillo® is an aroma variety of introduced by Virgil Gamache Farms Inc. in Washington state. The variety is characterized by mid to high alpha and low cohumulone content. Its aroma is reported to be similar to Cascade and the variety has good resistance to powdery mildew.

Pedigree	Open Pollination
Aroma/Flavor	Floral, citrus
Alpha Acids*	8.0 - 11.0 %
Beta Acids	6.0 - 7.0 %
Cohumulone	21 - 24 % of alpha acids
Total Oil	1.5 - 1.9 ml/100g
Myrcene	68 - 70 % of total oil
Humulene	9 - 11 % of total oil
Caryophyllene	2 - 4 % of total oil
Farnesene	2 - 4 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Apollo™

U.S.
High Alpha Hop

This super high alpha variety was developed through the Hopsteiner Breeding Program and released in 2006. It is resistant to powdery and downy mildew. Apollo® has very high alpha, good storage stability and low cohumulone. Added late into the brew boil, it is said to provide a strong grapefruit and hoppy note.

Pedigree	Daughter of Zeus
Aroma/Flavor	Strong grapefruit
Alpha Acids*	15.0 - 19.0%
Beta Acids	5.5 - 8.0 %
Cohumulone	24 - 28 % of alpha acids
Total Oil	1.5 - 2.5 ml/100g
Myrcene	30 - 55 % of total oil
Humulene	20 - 35 % of total oil
Caryophyllene	14 - 20 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Aramis

France

Aroma Hop

Aramis follows the most important aroma hop variety in the Alsace region – the traditional Strisselspalt. Aramis was established to create a variety with a similar aroma profile and polyphenol properties to Strisselspalt, but with increased and more stable bitter potential.

Pedigree	**Cross of Strisselspalt and Whitbread Golding**
Aroma/Flavor	**Typical with spicy and citrus notes**
Alpha Acids*	**7.9 - 8.3 %**
Beta Acids	**3.8 - 4.5 %**
Cohumulone	**20 - 25 % of alpha acids**
Total Oil	**1.2 - 1.6 ml/100g**
Myrcene	**40 % of total oil**
Humulene	**20 - 25 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Aurora

Slovenia
Aroma Hop

Aurora has an intense and pleasant hoppy aroma and exhibits a very good storage stability. Beer prepared with this variety has been shown to have good organoleptic scores with an intense and pleasant hop note. The yield of alpha acids is very good when brewing with this variety. Aurora is sensitive to aphids.

Pedigree	**Diploid hybrid of Northern Brewer and TG seedling of unknown origin**
Aroma/Flavor	**Intense and pleasant**
Alpha Acids*	**7.0 - 9.0 %**
Beta Acids	**3.0 - 5.0 %**
Cohumulone	**23 - 28 % of alpha acids**
Total Oil	**0.9 - 1.4 ml/100g**
Myrcene	**35 - 53 % of total oil**
Humulene	**20 - 27 % of total oil**
Caryophyllene	**4 - 8 % of total oil**
Farnesene	**6 - 9 % of total oil**
Storage Stability	**Good - Very Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Azacca®

U.S.
Aroma Hop

Azacca is named for the Haitian god of agriculture. It was developed through the American Dwarf Hop Association in Yakima and formerly known as experimental ADHA 483. Azacca® is a high alpha, high oil variety which exhibits a complex range of aromas including mango, papaya, orange, grapefruit, lemon, pine, spice, pineapple and grassy.

Pedigree	**Daughter of Toyomidori & ADHA 94/95**
Aroma/Flavor	**High citrus; tropical fruit**
Alpha Acids*	**14 - 16 %**
Beta Acids	**4.0- 5.5 %**
Cohumulone	**38 – 45 % of alpha acids**
Total Oil	**1.6 - 2.5 ml/100g**
Myrcene	**46 - 55 % of total oil**
Humulene	**14 - 18 % of total oil**
Caryophyllene	**8 - 12 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Boadicea

U.K.

Dual Purpose Hop

Boadicea is a dwarf variety and bred as a general purpose variety with moderate alpha and good flavor. It has a mellow citrus flavor with a light flowery aroma and faint lime-like aroma. Boadicea is derived from an open pollination of a second-generation female from a wild Japanese hop.

Pedigree	Dwarf variety by open pollination
Aroma/Flavor	Mellow citrus, floral, lime
Alpha Acids*	7.0 - 10.0%
Beta Acids	3 - 4 %
Cohumulone	23 - 29 % of alpha acids
Total Oil	1.4 - 2.0 ml/100g
Myrcene	30 - 34 % of total oil
Humulene	18 - 22 % of total oil
Caryophyllene	15 - 19 % of total oil
Farnesene	4 - 6 % of total oil
Storage Stability	Fair to good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Bobek
(Styr. Golding B)

Slovenia

Aroma Hop

Bobek is a diploid hybrid cross between Northern Brewer and TG seedling of unknown origin. It has an intense and pleasant aroma known for its very good agronomic traits in hop production and processing.

Pedigree	Diploid hybrid between Northern Brewer and a TG seedling of unknown origin
Aroma/Flavor	Intense and pleasant
Alpha Acids*	3.5 - 7.8 %
Beta Acids	4.0 - 6.1 %
Cohumulone	25 - 30 % of alpha acids
Total Oil	0.7 - 4.0 ml/100g
Myrcene	49 - 57 % of total oil
Humulene	13 - 19 % of total oil
Caryophyllene	4 - 6 % of total oil
Farnesene	4 - 7 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Bohemie

Czechia

Aroma Hop

Bohemie was bred from Saaz and Sládek, and was released in 2010 from the Hop Research Institute Co., Ltd. in Zatec, Czechia. The variety yields better than Saaz and has firm hop cones which makes it easy to pick. It shows very good tolerance to powdery mildew and medium resistance to downy mildew.

Pedigree	Cross between Saaz and Sládek cultivars
Aroma/Flavor	Slightly spicy, hoppy
Alpha Acids*	5.0 - 8.0 %
Beta Acids	6.0 - 9.0 %
Cohumulone	23 - 26 % of alpha acids
Total Oil	1.0 - 1.5 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	17 - 23 % of total oil
Caryophyllene	7 - 10 % of total oil
Farnesene	1 - 3 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Bor

Czechia
Dual Purpose Hop

Bor, which means pine, was registered as a dual purpose variety in 1994 and was named after the pinewoods which are typical for a region in Czechia. The hop was derived from Northern Brewer, and is resistant to downy mildew but somewhat susceptible to powdery mildew.

Pedigree	Originated from Northern Brewer
Aroma/Flavor	Slightly spicy, fruity, floral, some citrus
Alpha Acids*	6.0 - 9.0 %
Beta Acids	3.0 - 5.5 %
Cohumulone	22 - 27 % of alpha acids
Total Oil	1.2 - 2.0 ml/100g
Myrcene	40 - 55 % of total oil
Humulene	25 - 40 % of total oil
Caryophyllene	9 - 14 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Bramling Cross

U.K.

Aroma Hop

Developed in 1927 by Professor Salmon at Wye, from a cross of Bramling (one of the traditional Golding varieties) with a male seedling of the Manitoban wild hop. This variety has good yield, early ripening, tolerance to wilt and moderate resistance to mildews.

Pedigree	Bramling with a male seedling of the Canadian Manitoban wild hop
Aroma/Flavor	Fruity with black current notes
Alpha Acids*	6.0 - 8.0 %
Beta Acids	2.3 – 3.5 %
Cohumulone	30 - 55 % of alpha acids
Total Oil	0.7 - 1.2 ml/100g
Myrcene	34 - 38 % of total oil
Humulene	20 - 30 % of total oil
Caryophyllene	10 - 15 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Bravo™

U.S.
High Alpha Hop

Bravo is a second generation super high alpha variety that was developed by the Hopsteiner Breeding Program and released in 2006. It has good resistance to powdery mildew. Bravo is an excellent bittering hop that provides pleasant fruity and floral aroma characteristics.

Pedigree	Daughter of Zeus
Aroma/Flavor	Fruity and floral
Alpha Acids*	14.0 - 17.0 %
Beta Acids	3.0 - 5.0 %
Cohumulone	29 - 34 % of alpha acids
Total Oil	1.6 - 2.4 ml/100g
Myrcene	25 - 50 % of total oil
Humulene	18 - 20 % of total oil
Caryophyllene	10 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Brewers Gold

U.K.

Dual Purpose Hop

Prof. E.F. Salmon of Wye College in Kent England was responsible for breeding the variety Brewers Gold. This variety is not only well known all over the globe, but has been used in breeding purposes worldwide due to its moderate alpha acid content, high yield, and vigorous growth.

Pedigree	**Wild Manitoba BB1 with open pollination**
Aroma/Flavor	**Black currant, fruity, spicy**
Alpha Acids*	**4.5 - 6.5 %**
Beta Acids	**2.5 - 3.5 %**
Cohumulone	**40 - 48 % of alpha acids**
Total Oil	**0.8 - 1.8 ml/100g**
Myrcene	**40 - 50 % of total oil**
Humulene	**29 - 31 % of total oil**
Caryophyllene	**7 - 8 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Fair**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Calypso™

U.S.
Aroma Hop

Calypso is a diploid aroma-type hop developed from the Hopsteiner breeding program and exhibits pleasant fruity characteristics. It is resistant to powdery and downy mildews.

Pedigree	Cross between Hopsteiner female hop source and male derived from Nugget
Aroma/Flavor	Pleasant fruity with pear and apple
Alpha Acids*	12.0 - 14.0 %
Beta Acids	5.0 - 6.0 %
Cohumulone	40 - 42 % of alpha acids
Total Oil	1.6 - 2.5 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	20 - 35 % of total oil
Caryophyllene	9 - 15 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Cascade

U.S.
Aroma Hop

Cascade was developed in the USDA breeding program at Oregon State University and released as a U.S. aroma variety in 1972. It is characterized by its dark green elongated cone with an aroma that is of medium strength often described as a distinctive floral, grapefruit-like character. Cascade is the definitive hop for American craft brews.

Pedigree	Cross of English Fuggle with male originating from Russian variety Serebrianka
Aroma/Flavor	Unique floral, citrus
Alpha Acids*	4.5 - 7.0 %
Beta Acids	4.8 - 7.0 %
Cohumulone	33 - 40 % of alpha acids
Total Oil	0.7 - 1.4 ml/100g
Myrcene	45 - 60 % of total oil
Humulene	8 - 13 % of total oil
Caryophyllene	3 - 6 % of total oil
Farnesene	3 - 7 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Cashmere

U.S.
Aroma Hop

Cashmere was developed and released though the Washington State University USDA hop breeding program in 2013 and is a daughter of a Cascade male and a female line that includes Northern Brewer. It has a relatively mild herbal aroma with what is described as a smooth bitterness. It is moderate in alpha acids with low cohumulone.

Pedigree	Cascade and Northern Brewer
Aroma/Flavor	Mild herbal
Alpha Acids*	7.7 - 9.1 %
Beta Acids	6.4 - 7.1 %
Cohumulone	22 - 24 % of alpha acids
Total Oil	1.2 - 1.4 ml/100g
Myrcene	39 - 42 % of total oil
Humulene	26 - 29 % of total oil
Caryophyllene	11.5 – 13.5 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Celeia
(Styr. Golding C)

Slovenia

Aroma Hop

Celeia is a triploid hybrid from a cross of auto-tetraploid Savinjski Golding and the 105/58 hybrid between Aurora (Super Styrian) and a Slovenian wild hop. It is known for a noble hoppy aroma and pleasant bitterness. Celeia has widespread usage in both lager and ale beers.

Pedigree	Hybrid of Styrian Golding, Aurora, experimental line and Slovenian wild hop
Aroma/Flavor	Pleasant hoppy aroma
Alpha Acids*	3.0 - 6.5 %
Beta Acids	2.0 - 3.3 %
Cohumulone	27 - 31 % of alpha acids
Total Oil	1.5 - 3.6 ml/100g
Myrcene	26 - 40 % of total oil
Humulene	18 - 23 % of total oil
Caryophyllene	8 - 9 % of total oil
Farnesene	3 - 7 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Centennial

U.S.
Aroma Hop

Named after the Washington state centennial anniversary in 1989, Centennial is an aroma-type cultivar developed from the USDA hop breeding program at Washington State University in 1974 and released in 1990. Centennial is a well blended aroma hop and is sometimes referred to as Super Cascade.

Pedigree	Combination of Brewers Gold, Fuggle, East Kent Golding, and others
Aroma/Flavor	Floral and citrus
Alpha Acids*	9.5 - 11.5%
Beta Acids	3.4 - 4.5 %
Cohumulone	29 - 30 % of alpha acids
Total Oil	1.5 - 2.5 ml/100g
Myrcene	45 - 55 % of total oil
Humulene	10 - 18 % of total oil
Caryophyllene	5 - 8 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Challenger

U.K.

Dual Purpose Hop

Challenger was developed at Wye College UK from a cross made in 1963 and finally released in 1972. It is strongly resistant to downy mildew disease and was selected to meet the brewers' demand for flavor and bitterness as well as the growers' demands for disease resistance.

Pedigree	Bred from Northern Brewer and Target
Aroma/Flavor	Floral, spicy with some fruity
Alpha Acids*	6.5 - 9.0 %
Beta Acids	3.2 - 4.2 %
Cohumulone	20 - 25
Total Oil	1.0 - 1.5 ml/100g
Myrcene	28 - 32 % of total oil
Farnesene	1%

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Chelan

U.S.
High Alpha Hop

Chelan is a high alpha variety with a high beta content. The variety was developed through the John I. Haas, Inc., breeding program and released in 1994. Chelan is a daughter of Galena and has analytical data similar to Galena, but improved agronomic characteristics.

Pedigree	Daughter of Galena
Aroma/Flavor	Floral and citrus
Alpha Acids*	12.0 - 14.5 %
Beta Acids	8.5 - 9.8 %
Cohumulone	33 - 35 % of alpha acids
Total Oil	1.5 - 1.9 ml/100g
Myrcene	45 - 55 % of total oil
Humulene	12 - 15 % of total oil
Caryophyllene	9 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Chinook

U.S.
Dual Purpose Hop

Chinook was developed by the USDA breeding program in Washington State and released in 1985 as a high alpha variety but has gained favor in craft brewing with its distinctive aroma. This cultivar takes its name from a Native American tribe indigenous to the region around Washington state. The female parent is one of the English Goldings. The variety has a robust spicy, citrus aroma and grows vigorously in all areas.

Pedigree	**Cross of Petham Golding and USDA select male**
Aroma/Flavor	**Medium intense, spicy, piney, distinctive grapefruit**
Alpha Acids*	**12.0 - 14.0 %**
Beta Acids	**3.0 - 4.0 %**
Cohumulone	**29 - 35 % of alpha acids**
Total Oil	**1.7 - 2.7 ml/100g**
Myrcene	**35 - 40 % of total oil**
Humulene	**18 - 23 % of total oil**
Caryophyllene	**9 - 11 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Citra™

U.S.
Aroma Hop

Citra™ is an aroma hop variety released by the Hop Breeding Company, (a joint venture between John I. Haas, Inc. and Select Botanicals Group, LLC in the Yakima Valley) having unique and highly favored flavor characteristics. As the name suggests, its flavor descriptors include citrus including lime and grapefruit as well as various tropical fruity characters.

Pedigree	**50% Hallertau; 25% U.S. Tettnanger**
Aroma/Flavor	**Strong citrus, fruity**
Alpha Acids*	**11.0 - 13.0 %**
Beta Acids	**3.5 - 4.5 %**
Cohumulone	**22 - 24 % of alpha acids**
Total Oil	**2.2 - 2.8 ml/100g**
Myrcene	**60 - 65 % of total oil**
Humulene	**11 - 13 % of total oil**
Caryophyllene	**6 - 8 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Fair**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Cluster

U.S.
Bitter Hop

Cluster is one of the oldest varieties grown in the U.S. The rootstock origin is uncertain. Until the late 1970's, Cluster was one of only a few varieties grown in the U.S. and dominated the growing acreage. Alpha content is medium, aroma is strong and storage stability of the alpha acids is excellent. The variety grows with good vigor and cone production.

Pedigree	**Unknown but possibly cross between English variety and U.S. male hop**
Aroma/Flavor	**Floral and spicy**
Alpha Acids*	**5.5 - 8.5 %**
Beta Acids	**4.5 - 5.5 %**
Cohumulone	**37 - 43 % of alpha acids**
Total Oil	**0.4 - 0.8 ml/100g**
Myrcene	**45 - 55 % of total oil**
Humulene	**15 - 18 % of total oil**
Caryophyllene	**6 - 7 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Columbus

U.S.
High Alpha Hop

The current Super High Alpha varieties, which include the names Columbus, Tomahawk and Zeus (CTZ) have the same female parent as Nugget, making them at least half sisters to Nugget. The CTZ varieties are currently used extensively for beer bittering. CTZ's have very poor storage characteristics and are susceptible to mildews.

Pedigree	Nugget daughter
Aroma/Flavor	Aromatic, pungent
Alpha Acids*	15.0 - 17.0 %
Beta Acids	4.5 - 5.0 %
Cohumulone	28 - 32 % of alpha acids
Total Oil	2.5 - 3.5 ml/100g
Myrcene	50 - 60 % of total oil
Humulene	12 - 18 % of total oil
Caryophyllene	9 - 11 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Comet

U.S.
High Alpha Hop

Comet is a hop variety with relatively high alpha content and provides a "wild American" aroma. It was released as high alpha hop from the USDA hop breeding program in 1975 primarily for production in Washington and Idaho. It has become a popular variety grown in Germany. It is susceptible to downy mildew and resistant to verticillium wilt.

Pedigree	Open pollination
Alpha Acids*	9.4 - 12.4 %
Beta Acids	3.0 - 6.1 %
Cohumulone	40 - 45 % of alpha acids
Total Oil	1.4 - 3.3 ml/100g
Myrcene	40 - 65 % of total oil
Humulene	1 - 2 % of total oil
Caryophyllene	5 - 7 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Crystal

U.S.
Aroma Hop

Crystal is a triploid variety developed from the German aroma hop variety Hallertauer Mittelfrüh with lineage contributions from Cascade, Brewer's Gold and Early Green. Released in 1993 from the USDA breeding program, Crystal has become popular in U.S. craft brewing as a triploid Hallertauer type.

Pedigree	Half-sister of Mt. Hood and Liberty derived from Hallertau Mittelfrüh and other crosses
Aroma/Flavor	Mild, spicy and floral
Alpha Acids*	4.0 - 6.0 %
Beta Acids	5.0 - 6.7 %
Cohumulone	20 - 26 % of alpha acids
Total Oil	0.8 - 2.1 ml/100g
Myrcene	40 - 65 % of total oil
Humulene	18 - 24 % of total oil
Caryophyllene	4 - 8 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Delta™

U.S.
Aroma Hop

Delta is an aroma variety released in 2009 from the Hopsteiner hop breeding program. It has a mild slightly spicy aroma with some citrus notes; shows good resistance to downy mildew and moderate resistance to strains of powdery mildew.

Pedigree	**Cross between Fuggle and Cascade derived male**
Aroma/Flavor	**Pleasant spicy with citrus notes**
Alpha Acids*	**5.5 - 7.0 %**
Beta Acids	**5.5 - 7.0 %**
Cohumulone	**22 - 24 % of alpha acids**
Total Oil	**0.5 - 1.1 ml/100g**
Myrcene	**25 - 40 % of total oil**
Humulene	**30 - 40 % of total oil**
Caryophyllene	**9 - 15 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Denali™

U.S.
Dual Purpose Hop

Denali® is a moderately high-alpha hop with very high essential oil content. Its aroma characteristics include pineapple, pine and citrus. Denali™ was developed through the Hopsteiner hop breeding program in Yakima and was formerly know as Hopsteiner Experimental 06277. The pedigree is 50% Nugget, 25% Zeus and 25% USDA 19058m.

Pedigree	**Nugget, Zeus and USDA 19058m**
Aroma/Flavor	**Pineapple, pine and citrus**
Alpha Acids*	**13 - 16 %**
Beta Acids	**3.5 - 5.0 %**
Cohumulone	**22 - 26 % of alpha acids**
Total Oil	**3.0 - 4.5 ml/100g**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Dr. Rudi™

New Zealand
Dual Purpose

This triploid variety was previously released by the New Zealand Horticultural Research Center as “Super Alpha” in 1976 – renamed “Dr. Rudi” in 2012 to honor the New Zealand breeder/horticulturist who is considered the father of New Zealand’s hop program. The variety was once classified “super” alpha, but by today’s standards, it’s moderate. Dr. Rudi is derived from a Smoothcone mother and open pollination. Its aroma includes pine and citrus peel, as well as some lemongrass.

Pedigree	**Smoothcone, open pollination**
Aroma/Flavor	**Pine, citrus peel, lemongrass**
Alpha Acids*	**10 - 12 %**
Beta Acids	**7.0 - 8.5 %**
Cohumulone	**30 - 35 % of alpha acids**
Total Oil	**1.1 - 1.5 ml/100g**
Myrcene	**25 - 35 % of total oil**
Humulene	**31 - 35 % of total oil**
Caryophyllene	**9 - 11 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

East Kent Golding (EKG)

U.K.

Aroma Hop

EKG was developed from a wild Canterbury Whitebine variety in the late 1700's and brought to the market in 1790. The aroma has been described as gentle, fragrant, and pleasant, and is recognized as having a typical English character. Goldings are found to be useful for late hopping lagers, when a delicate aroma is required.

Pedigree	Clonal selection in 1790
Aroma/Flavor	Spicy with some citrus, earthy
Alpha Acids*	4.0 - 9.5 %
Beta Acids	1.9 - 3.0 %
Cohumulone	25 - 30 % of alpha acids
Total Oil	0.4 - 0.8 ml/100g
Myrcene	18 - 28 % of total oil
Humulene	34 - 45 % of total oil
Caryophyllene	12 - 17 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair to good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Ekuanot™

U.S. Aroma Hop

Ekuanot™ (formerly HBC 366) was commercially released in 2014 as "Equinox" by the Hops Breeding Company in Yakima, and subsequently renamed due to trademark issues. It has intense and unique fruity and citrus notes including melon, berry, citrus-lime, apple and papaya. Ekuanot™ also contains some spicy, green pepper note. The variety has high alpha acids content and high essential oil and is known for its vibrant yellow color during its early growth in the spring.

Note	Formerly HBC 366 and Equinox
Aroma/Flavor	Tropical fruit, fruit, citrus and spicy
Alpha Acids*	14.5 - 15.5 %
Beta Acids	4.5 - 5.5 %
Cohumulone	32 - 38 % of alpha acids
Total Oil	2.5 - 4.5 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	12 - 20 % of total oil
Caryophyllene	8 - 12 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

El Dorado®

U.S.
Aroma Hop

El Dorado® was released by CLS Farms LLC in Moxee Washington in 2010. Little information is available about its pedigree, but it is believed to be derived from a *neomexicanus* subspecies of *Humulus lupulus.* Its primary flavor character is fruity showing a blend of tropical fruit, watermelon and stone fruit.

Aroma/Flavor	Tropical fruit, watermelon, stone fruit
Alpha Acids*	14.0 - 16.0 %
Beta Acids	7.0 - 8.0 %
Cohumulone	28 - 33 % of alpha acids
Total Oil	2.5 - 2.8 ml/100g
Myrcene	55 - 60 % of total oil
Humulene	10 - 15 % of total oil
Caryophyllene	6 - 8 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Ella™

Australia
Aroma Hop

Ella is an versatile flavor hop developed through the Hop Products Australia breeding program (part of Barth-Haas Group). The hop contributes a combination of floral aromas with hints of anise. Ella™ is reminiscent of, yet distinctly different in character to noble European varieties, and provides a contrast to the citrus and tropical fruit characters of many modern flavor hop varieties. It grows vigorously, producing moderately large, dense cones.

Pedigree	Australian breeding material
Aroma/Flavor	Spice and floral
Alpha Acids*	12.3 - 16.3 %
Beta Acids	4.0 - 6.8 %
Cohumulone	32 - 38 % of alpha acids
Total Oil	1.8 - 2.6 ml/100g
Myrcene	38 - 43 % of total oil
Humulene	16 - 22 % of total oil
Caryophyllene	13 - 16 % of total oil
Farnesene	<2 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Endeavour

U.K.

Aroma Hop

Endeavour is a dwarf variety from a cross made in 2002 at Wye Hops in the UK. This variety imparts unique English flavor notes to beer including citrus, spicy and red fruits. It is resistant to powdery and downy mildews.

Pedigree	**Seedling of Cascade and granddaughter of Target**
Aroma/Flavor	**Unique English aroma with spicy and fruity notes**
Alpha Acids*	**8.0 - 10.5 %**
Beta Acids	**3.8 - 5.3 %**
Cohumulone	**30 - 36 % of alpha acids**
Total Oil	**1.1 - 1.7 ml/100g**
Myrcene	**27 - 37 % of total oil**
Humulene	**3 - 10 % of total oil**
Farnesene	**5 - 8 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Enigma™

Australia
Aroma Hop

This hop was released by the Hop Products Australia breeding program (Barth-Haas Group). Technically, Enigma™ is a descendent of Tettnanger, but has a range of flavors more characteristic to that found in a North American hop. It has a high alpha content, but is known more for its complex fruity character which includes raspberry, red current, light tropical and "Pinot Gris" notes.

Pedigree	Tettnanger, North American hop
Aroma/Flavor	White wine, Red fruits and light tropical
Alpha Acids*	14.5 - 16.5 %
Beta Acids	4.5 - 6.0 %
Cohumulone	37 - 43 % of alpha acids
Total Oil	1.8 - 3.0 ml/100g
Myrcene	20 - 35 % of total oil
Humulene	12 - 19 % of total oil
Caryophyllene	6 - 8 % of total oil
Farnesene	7 - 12 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Eureka!™

U.S.
High Alpha Hop

This hop produces a very high alpha content approaching 20% but is also noted for its dark fruits aroma including black current. Eureka!™ also has some herbal and pine notes. Released by Hopsteiner, it was formerly know as Experimental Hop 05256.

Pedigree	Apollo and Merkur
Aroma/Flavor	Black current, dark fruits, herbal, pine
Alpha Acids*	17.0 - 19.9 %
Beta Acids	4.6 - 6.0 %
Cohumulone	28 - 30 % of alpha acids
Total Oil	2.5 - 4.4 ml/100g
Farnesene	0.1 - 0.3 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Extra Styrian Dana

Slovenia

Dual Purpose Hop

Extra Styrian Dana is a dual purpose variety bred from German Hallertau Magnum and Slovenian genetic hop material at the Slovenian Institute of Hop Research and Brewing. The variety gives good agronomic yields and offers an intense hoppy aroma as well as a high level of alpha acids.

Pedigree	Bred from German Hallertau and Slovenian genetic hop material
Aroma/Flavor	Pleasant and robust
Alpha Acids*	12.5 - 18.8 %
Beta Acids	4.2 - 6.0 %
Cohumulone	28 - 31 % of alpha acids
Total Oil	2.4 - 3.9 ml/100g
Myrcene	42 - 60 % of total oil
Humulene	15 - 22 % of total oil
Caryophyllene	6 - 8 % of total oil
Farnesene	7 - 9 % of total oil
Storage Stability	Very good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

First Gold

U.K.

Aroma Hop

First Gold is a dwarf variety bred at Wye College in the UK resulting from a cross between Whitbread Golding and a dwarf male. It is suitable both as a general kettle hop and also for late and dry hopping in all types of beer. First Gold has excellent aroma qualities and much of the flavor character of Whitbread hops.

Pedigree	**Daughter of Whitbread Golding and male dwarf variety**
Aroma/Flavor	**Typical with spicy and citrus notes**
Alpha Acids*	**6.5 - 10.0 %**
Beta Acids	**3.0 - 4.5 %**
Cohumulone	**32 - 35 % of alpha acids**
Total Oil	**0.7 - 1.7 ml/100g**
Myrcene	**30 - 38 % of total oil**
Humulene	**20 - 24 % of total oil**
Caryophyllene	**6 - 7 % of total oil**
Farnesene	**1.5 - 3.0 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Fuggle

U.K.

Aroma Hop

Named after the Kent grower that introduced it in 1875, Fuggle has been revered ever since as the classic aroma hop for British Bitters and Pale Ales. The variety is often used in combination with Goldings. Fuggle has typical English aroma whose robust character contributes nicely to beer flavor. Sometimes it is used as a distinctive dry hop.

Pedigree	Land variety
Aroma/Flavor	Typical English aroma
Alpha Acids*	3.5 - 6.5 %
Beta Acids	2.0 - 4.0 %
Cohumulone	27 - 33 % of alpha acids
Total Oil	0.7 - 1.1 ml/100g
Myrcene	25 - 30 % of total oil
Humulene	30 - 38 % of total oil
Caryophyllene	9 - 13 % of total oil
Farnesene	6 - 8 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Galaxy™

Australia
Aroma Hop

The Australian variety Galaxy was developed from the breeding program at Hop Products Australia (Barth-Haas Group) and is attracting much attention as a high-impact flavor hop. When used as a late addition, it contributes a striking and distinctive citrus and passion fruit character. Developed and grown exclusively in Australia, Galaxy is a late maturing seedless cultivar.

Pedigree	**Australian high-alpha female and Australian male from Perle**
Aroma/Flavor	**Intense passion fruit, citrus**
Alpha Acids*	**12.5 - 15.5 %**
Beta Acids	**6.0 - 9.0 %**
Cohumulone	**32 - 42 % of alpha acids**
Total Oil	**1.8 - 3.0 ml/100g**
Myrcene	**39 - 57 % of total oil**
Humulene	**1 - 2 % of total oil**
Caryophyllene	**7 - 13 % of total oil**
Farnesene	**3 - 5 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Galena

U.S.
High Alpha Hop

The name Galena is from the ancient Roman term for the mineral galenite which occurs in the soils of Oregon and the namesake hop variety is grown there. Galena is a high alpha variety developed in the USDA breeding program in Idaho and released as a variety in 1978. It is characterized by high alpha acids and a relatively high beta acids content.

Pedigree	Open pollination of Brewers Gold
Aroma/Flavor	Mild citrus notes
Alpha Acids*	11.5 - 13.5 %
Beta Acids	7.2 - 8.7 %
Cohumulone	36 - 40 % of alpha acids
Total Oil	0.9 - 1.3 ml/100g
Myrcene	55 - 60 % of total oil
Humulene	10 - 13 % of total oil
Caryophyllene	3 - 5 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good to excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Glacier

U.S.
Dual Purpose Hop

Glacier is a Dual Purpose hop with well balanced bittering properties and a pleasant aroma profile. It was released from the Washington State University USDA breeding program in 2000, and selected for its low cohumulone content and good yield potential. Glacier exhibits a pleasant hoppy aroma.

Pedigree	Cross between French Elsasser female and USDA experimental male
Aroma/Flavor	Mild and pleasant
Alpha Acids*	3.3 - 9.7 %
Beta Acids	5.4 - 9.5 %
Cohumulone	11 - 13 % of alpha acids
Total Oil	0.7 - 1.6 ml/100g
Myrcene	33 - 62 % of total oil
Humulene	24 - 36 % of total oil
Caryophyllene	6 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Green Bullet

New Zealand
Dual Purpose Hop

This triploid variety was released in 1972 from the New Zealand DSIR breeding program (now Plant and Food Research) as a high alpha hop. Brewers have now recognized its aroma qualities which include high levels of floral with a piney resinous character. In beer, the hop is said to deliver a spicy note similar to that found with a Styrian hop.

Pedigree	Open pollination of Smoothcone
Aroma/Flavor	Floral, piney, resinous
Alpha Acids*	11 - 14 %
Beta Acids	6.5 - 7.0 %
Cohumulone	38 - 39 % of alpha acids
Total Oil	1.0 - 1.2 ml/100g
Myrcene	37 - 39 % of total oil
Humulene	27 - 29 % of total oil
Caryophyllene	8 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Hallertau Blanc

Germany

Aroma Hop

Hallertau Blanc is a German variety with a bouquet of tropical fruits, stone fruits and grapefruit. The variety was bred at Hüll, released 2012 and is one of the varieties which have been bred and commercialized in response to demand from the craft beer industry's desire for bold tastes and differentiating flavors.

Pedigree	Daughter of Cascade
Aroma/Flavor	Tropical fruit and grapefruit
Alpha Acids*	9.0 - 12.0 %
Beta Acids	4.5 - 5.5 %
Cohumulone	22 - 26 % of alpha acids
Total Oil	1.5 ml/100g
Myrcene	70 % of total oil
Humulene	0 - 3 % of total oil
Caryophyllene	0 - 2 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Hallertau Mittelfrüh

Germany

Aroma Hop

This is a classic German variety with fine aroma and average bitter content. Because of its high susceptibility to wilt, Hallertau Mittelfrüh had suffered from a dramatic decrease in cultivation in the 1990s, but with an increasing demand and availability of virus-free plant material, Hallertau Mittelfrüh is again a popular variety.

Pedigree	German land variety
Aroma/Flavor	Classic noble with herbal notes
Alpha Acids*	3.0 - 5.5 %
Beta Acids	3.0 - 5.0 %
Cohumulone	18 - 28 % of alpha acids
Total Oil	0.7 - 1.3 ml/100g
Myrcene	20 - 28 % of total oil
Humulene	45 - 55 % of total oil
Caryophyllene	10 - 15 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Harmonie

Czechia

Aroma Hop

Harmonie was registered in 2004 and is a high beta variety with moderate alpha content. Current acreage is limited but it has shown very good quality for its contribution to pilsner beer aroma in Czechia. Its name comes from the "harmonious structure of hop resins".

Pedigree	**Multiple hybrid with nearly 60% Saaz in its origin**
Aroma/Flavor	**Pleasant slightly spicy, citrus**
Alpha Acids*	**2.4 - 4.5 %**
Beta Acids	**4.0 - 6.0 %**
Cohumulone	**23 - 26 % of alpha acids**
Total Oil	**0.4 - 0.8 ml/100g**
Myrcene	**25 - 40 % of total oil**
Humulene	**15 - 30 % of total oil**
Caryophyllene	**6 - 9 % of total oil**
Farnesene	**14 - 20 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Helga™

Australia
Aroma Hop

Helga is an aroma hop developed in Australia from the German cultivar Hallertau Mittelfrüh. With low to moderate levels of alpha acids and high humulene, Helga provides the typical chemical and aroma characteristics of a European aroma hop. Grown only in Tasmania, Helga is described as having delicate floral and subtle herbal notes.

Pedigree	**Selected in Australia from Hallertau Mittelfrüh**
Aroma/Flavor	**European noble aroma; floral, herbal**
Alpha Acids*	**4.9 - 7.3 %**
Beta Acids	**3.6 - 5.6 %**
Cohumulone	**17 - 24 % of alpha acids**
Total Oil	**0.6 - 1.0 ml/100g**
Myrcene	**7 - 14 % of total oil**
Humulene	**44 - 66 % of total oil**
Caryophyllene	**11 - 15 % of total oil**
Farnesene	**<1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Herkules

Germany

High Alpha Hop

True to its name, Herkules is a robust, high-yielding, high bittering hop cultivar tolerant to various diseases. It was released in 2006 by the Hüll Hop Research Center in Germany. Herkules has excellent brewing quality combined with very good storage stability.

Pedigree	Daughter of Taurus
Aroma/Flavor	Robust hoppy with some citrus and melon
Alpha Acids*	12.0 - 17.0 %
Beta Acids	4.0 - 5.5 %
Cohumulone	32 - 38 % of alpha acids
Total Oil	1.6 - 2.4 ml/100g
Myrcene	30 - 50 % of total oil
Humulene	30 - 45 % of total oil
Caryophyllene	7 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Hersbrucker

Germany

Aroma Hop

This traditional German variety is from the Hersbrucker growing area and exhibits a fine noble aroma but sometimes shows a very low alpha content. It was once considered a successor to Hallertauer Mittelfrüh with a good tolerance to diseases, but both varieties have now achieved popularity and sustainability.

Pedigree	German land variety
Aroma/Flavor	Noble aroma type
Alpha Acids*	1.5 - 4.0 %
Beta Acids	2.5 - 6.0 %
Cohumulone	17 - 25 % of alpha acids
Total Oil	0.5 - 1.0 ml/100g
Myrcene	15 - 30 % of total oil
Humulene	20 - 30 % of total oil
Caryophyllene	8 - 13 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair to poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Horizon

U.S.
Dual Purpose Hop

A diploid high alpha hop, Horizon was a USDA selection of a cross made in Oregon in 1970 and released in 1997. It is a half sister of Nugget with a breeding line that includes Brewers Gold, Early Green Hops and a USDA experimental variety. It is notably low in cohumulone with high myrcene content and has a pleasant aroma consisting of floral and spicy.

Pedigree	Half-sister of Nugget
Aroma/Flavor	Floral and spicy
Alpha Acids*	11.0 - 13.0 %
Beta Acids	6.5 - 8.5 %
Cohumulone	16 - 19 % of alpha acids
Total Oil	1.5 - 2.0 ml/100g
Myrcene	55 - 65 % of total oil
Humulene	11 - 13 % of total oil
Caryophyllene	7 - 9 % of total oil
Farnesene	2 - 4 % of total oil
Storage Stability	Fair to good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Hüll Melon

Germany

Aroma Hop

Hüll Melon is a variety from Germany with distinctive honeydew melon and strawberry aroma. The variety was bred at Hüll, and released in 2012 as one of the varieties bred and commercialized in response to demand from the craft beer industry's desire for bold tastes and differentiating flavors.

Pedigree	Daughter of Cascade
Aroma/Flavor	Distinctive melon
Alpha Acids*	6.9 - 7.5 %
Beta Acids	7.3 - 7.9 %
Cohumulone	25 - 30 % of alpha acids
Total Oil	0.8 ml/100g
Myrcene	36 % of total oil
Humulene	10 - 20 % of total oil
Caryophyllene	5 - 10 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Jarrylo™

U.S.
Aroma Hop

Jarrylo™ was developed and released by the American Dwarf Hop Association and formerly known as experimental ADHA 881. The name is derived from the Slavic god of fertility and springtime and is pronounced Jar-ril-low. Its father is Summit and mother is ADHA 75-2. Jarrylo™ is notable for its fruity character, especially banana and pear, but also exhibits some spice and grassy.

Pedigree	Summit and ADHA 75-2
Aroma/Flavor	Fruity with some spice
Alpha Acids*	15 - 17 %
Beta Acids	6.0 - 7.5 %
Cohumulone	34 - 37 % of alpha acids
Total Oil	3.6 - 4.3 ml/100g
Myrcene	40 - 55 % of total oil
Humulene	15 - 18 % of total oil
Caryophyllene	8 - 11 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Iunga

Poland

Bitter Hop

Iunga (also known as Junga) was released 2004 from the State Agricultural Institute in Pulawy Poland as high alpha variety and was bred from Northern Brewer and Marynka. It has moderately high alpha acids and displays classic earthy, spicy and fruity aroma notes.

Pedigree	Bred from Northern Brewer and Marynka
Aroma/Flavor	Earthy, spicy and fruity notes
Alpha Acids*	10.0 - 14.0 %
Beta Acids	5.0 - 7.0 %
Cohumulone	29 - 34 % of alpha acids
Total Oil	1.5 - 2.5 ml/100g
Myrcene	40 - 55 % of total oil
Humulene	30 - 40 % of total oil
Caryophyllene	8 - 11 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Kazbek

Czechia

Aroma Hop

Kazbek was a selection from hybrid progenies of breeding material originating from Russian wild hops. It was released in 2008 and exhibits a spicy lemon aroma. The name Kazbek is from the highest peak within middle Caucasus mountain range in Czechia.

Pedigree	Breeding material with origin in Russian wild hops
Aroma/Flavor	Spicy, lemon citrus
Alpha Acids*	5.0 - 8.0 %
Beta Acids	4.0 - 6.0 %
Cohumulone	35 - 40 % of alpha acids
Total Oil	0.9 - 1.8 ml/100g
Myrcene	40 - 55 % of total oil
Humulene	20 - 35 % of total oil
Caryophyllene	10 - 15 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Kohatu

New Zealand
Dual Purpose Hop

Kohatu is a triploid variety released in 2011 from the New Zealand Plant & Food Research hop breeding program. It is derived from a Hallertau Mittelfrüh female and New Zealand male hop with European and North American heritage. The hop is noted for its intense tropical fruit character.

Pedigree	Hallertau Mittelfrüh and NZ male
Aroma/Flavor	Intense tropical fruit
Alpha Acids*	6.0 - 7.0 %
Beta Acids	4.0 - 5.0 %
Cohumulone	20- 22 % of alpha acids
Total Oil	0.8 - 1.2ml/100g
Myrcene	33 - 37 % of total oil
Humulene	25 - 28 % of total oil
Caryophyllene	11 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Lemon Drop™

U.S.
Aroma Hop

Lemon Drop™ is a distinctive aroma variety developed through the Hopsteiner hop breeding program, previously known as Experimental 01210. Its flavors include a prominent lemon with mint, green tea and a slight melon as a backdrop. The mother is a Cascade and father is USDA 19058. Lemon Drop® has a medium alpha content similar to Cascade and has some susceptibility to powdery mildew.

Pedigree	Cascade and USDA 19058
Aroma	Lemon citrus, mint, green tea
Alpha Acids*	5 - 7 %
Beta Acids	4 - 6 %
Cohumulone	28 - 34 % of alpha acids
Total Oil	1.5 - 2.0 ml/100g
Farnesene	6 - 7 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Liberty

U.S.
Aroma Hop

Liberty is a triploid variety bred from a cross between a female Hallertau Mittelfrüh and a downy mildew resistant German male hop. The variety was developed in 1983 from the USDA program at Oregon State University and released in the U.S. in 1991. Of the four U.S. triploid Hallertau varieties released during that time, Liberty most closely resembles Hallertau Mittelfrüh.

Pedigree	Triploid from Hallertau Mittelfrüh and German aroma male hop
Aroma	Mild, slightly spicy, floral
Alpha Acids*	3.0 - 5.0 %
Beta Acids	3.0 - 4.0 %
Cohumulone	24 - 30 % of alpha acids
Total Oil	0.6 - 1.2 ml/100g
Myrcene	20 - 40 % of total oil
Humulene	35 - 40 % of total oil
Caryophyllene	9 - 12 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Poor to fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Loral™

U.S.
Aroma Hop

Loral™ was developed by the Hop Breeding Company and released in 2016; previously known as HBC 291. It provides pleasant floral and herbal notes reminiscent of a noble aroma hop. Loral's mother is U.S. Glacier and her grandmother the long established French noble aroma variety Tardif de Bourgogne. The father is a son of the Nugget variety. Loral is characterized by having numerous small, dense cones with moderate alpha acids.

Pedigree	**U.S. Glacier and U.S. Nugget**
Aroma/Flavor	**Floral, herbal, citrus**
Alpha Acids*	**10.0 - 12.0 %**
Beta Acids	**4.5 - 5.5 %**
Cohumulone	**21 - 23 % of alpha acids**
Total Oil	**1.5 - 2.5 ml/100g**
Myrcene	**37 - 39 % of total oil**
Humulene	**23 - 25 % of total oil**
Caryophyllene	**6 - 8 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Lublin

Poland

Aroma Hop

Originating from the Saaz hop, this variety has very fine aroma characteristics. Currently, Lublin is cultivated in the Polish growing regions Lublin, Poznan and Opole. It is average in alpha and yield, however its agronomic performance is better than that of Saaz. Lublin has a good tolerance to diseases and grows on light to medium heavy soils.

Pedigree	Descendent of Saaz
Aroma	Noble aroma Saaz-type
Alpha Acids*	3.0 - 4.5 %
Beta Acids	3.0 - 4.0 %
Cohumulone	25 - 28 % of alpha acids
Total Oil	0.5 - 1.1 ml/100g
Myrcene	22 - 29 % of total oil
Humulene	30 - 40 % of total oil
Caryophyllene	6 - 11 % of total oil
Farnesene	10 - 14 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Magnat

Poland

High Alpha Hop

Magnat is a high alpha variety developed by IUNG Poland and released in 2012. It is a daughter of German Magnum, from which its name is derived. Magnat has high yields and a favorable late maturity. Its aroma is described as pleasant.

Pedigree	Daughter of Magnum
Aroma/Flavor	Pleasant
Alpha Acids*	11.0 - 16.0 %
Beta Acids	3.0 - 7.0 %
Total Oil	1.0 - 2.0 ml/100g
Myrcene	30 - 40 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Magnum

Germany

High Alpha Hop

This high alpha variety was bred in 1980 at Hüll Hop Research Center in Germany and is known for its extremely large and heavy cones. It produces good yields, and like many of the Hüll varieties, Hallertauer Magnum has a high tolerance to disease.

Pedigree	**Daughter of U.S. Galena**
Aroma	**Spicy with some fruity**
Alpha Acids*	**11.0 - 16.0 %**
Beta Acids	**5.0 - 7.0 %**
Cohumulone	**21 - 29 % of alpha acids**
Total Oil	**1.6 - 2.6 ml/100g**
Myrcene	**30 - 45 % of total oil**
Humulene	**30 - 45 % of total oil**
Caryophyllene	**8 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Mandarina Bavaria

Germany
Aroma Hop

Mandarina Bavaria is a German aroma hop with a pleasant fruitiness and very distinctive tangerine and citrus notes. The variety was bred at Hüll and released 2012 in response to demand from the craft beer industry and the desire for bold tastes and differentiating flavors.

Pedigree	Daughter of Cascade
Aroma	Fruity and citrus
Alpha Acids*	7.0 - 10.0 %
Beta Acids	5.0 - 6.5 %
Cohumulone	31 - 35 % of alpha acids
Total Oil	2.2 ml/100g
Myrcene	71 % of total oil
Humulene	5 - 15 % of total oil
Caryophyllene	1 - 5 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Marco Polo

China

High Alpha Hop

Marco Polo is a CTZ (Columbus, Tomahawk, Zeus) derived hop grown and marketed in China. It makes up a minor portion of China's hop acreage.

Pedigree	Columbus
Aroma	Pungent
Alpha Acids*	12.0 - 13.0 %
Beta Acids	4.5 - 5.5 %
Cohumulone	30 - 35 % of alpha acids
Total Oil	1.1 ml/100g
Myrcene	40 - 50 % of total oil
Humulene	15 - 25 % of total oil
Caryophyllene	8 - 12 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Marynka

Poland

Bitter Hop

Marynka was bred in Poland from a Brewers Gold mother and Slovenian father hop, and was registered in 1988. It is primarily a bitter hop but exhibits an assertive herbal, hoppy aroma. It is also characterized by a very high level of beta acids. Marynka has strong aroma characteristics and good resistance to most pests and diseases.

Pedigree	Daughter of Brewers Gold
Aroma	Assertive hoppy, herbal
Alpha Acids*	9.0 - 12.0 %
Beta Acids	10.2 - 13.0 %
Cohumulone	26 - 33 % of alpha acids
Total Oil	1.8 - 2.2 ml/100g
Myrcene	28 - 31 % of total oil
Humulene	26 - 33 % of total oil
Caryophyllene	11 - 12 % of total oil
Farnesene	1 - 3 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Merkur

Germany
High Alpha Hop

Merkur is a German high-alpha variety bred at the Hop Research Center in Hüll Germany and was registered in 2001. It shows good resistance to powdery mildew and moderate agronomic yield. Its aroma is described as earthy with some citrus notes.

Pedigree	Cross between Hallertau Magnum and German experimental variety
Aroma	Earthy and citrus notes
Alpha Acids*	12.0 - 14.0 %
Beta Acids	4.5 - 5.5 %
Cohumulone	18 - 20 % of alpha acids
Total Oil	2.0 - 3.0 ml/100g
Myrcene	45 - 50 % of total oil
Humulene	28 - 32 % of total oil
Caryophyllene	8 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Millennium®

U.S.
High Alpha Hop

Millennium is a high alpha variety developed through the John I. Haas, Inc., breeding program and released in 2000, the turn of the millennium. With Nugget as the mother, this triploid variety exhibits the same powdery mildew resistance as Nugget and its brewing profile is comparable to that of Nugget and Columbus-type varieties.

Pedigree	**Triploid high-alpha; Nugget mother**
Aroma	**Mild, somewhat pungent**
Alpha Acids*	**14.5 - 16.5 %**
Beta Acids	**4.3 - 5.3 %**
Cohumulone	**28 - 32 % of alpha acids**
Total Oil	**1.8 - 2.2 ml/100g**
Myrcene	**30 - 40 % of total oil**
Humulene	**23 - 27 % of total oil**
Caryophyllene	**9 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Mistral

France

Aroma Hop

Mistral is a French variety released by the Comptoir Agricole breeding program in 2016. It has a medium alpha content but is recognized more for its subtle but distinctive fruity character which includes citrus, passion fruit, mango and orange notes.

Aroma	Citrus, passion fruit, mango, orange
Alpha Acids*	6.5 - 8.5 %
Beta Acids	3.1 - 3.8 %
Cohumulone	29 - 39 % of alpha acids
Total Oil	1.0 - 1.5 ml/100g
Myrcene	59 - 65 % of total oil
Humulene	9.5 - 12.8 % of total oil
Caryophyllene	3.0 - 4.1 % of total oil
Farnesene	2.5 - 3.5 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Monroe

Germany

Aroma Hop

The new German hop variety Monroe has a very low alpha content with moderate essential oils. Its aroma is described as red berries including raspberry, cherries and orange syrup. Little is written about its lineage except that Monroe is derived from a wild American hop.

Pedigree	Wild American Hop
Aroma	Red fruits, raspberry, cherry, orange
Alpha Acids*	2.5 %
Total Oil	1.0 ml/100g

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Mosaic™

U.S.
Aroma Hop

Mosaic™ is an aroma hop variety developed by Hop Breeding Company LLC (John I. Haas, Inc. and Select Botanicals Group) and released in 2012. Mosaic™ offers a unique and complex blend of floral, tropical, fruity, and earthy characteristics that translate very favorably into several styles of beer. Mosaic™ is the daughter of YCR 14 Simcoe® and a Nugget derived male.

Pedigree	**Daughter Simcoe® and Nugget male**
Aroma	**Floral and fruity**
Alpha Acids*	**11.5 - 13.5 %**
Beta Acids	**3.2 - 3.9 %**
Cohumulone	**24 - 26 % of alpha acids**
Total Oil	**1.0 - 1.5 ml/100g**
Myrcene	**47 - 53 % of total oil**
Humulene	**13 - 16 % of total oil**
Caryophyllene	**5 - 8 % of total oil**
Farnesene	**0 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Motueka

New Zealand Aroma Hop

Motueka is a triploid hop developed at the HortResearch center in New Zealand and is a cross of Saaz and a New Zealand breeding selection. Its aroma is described as lively, with notes of lemon-lime and some tropical fruit.

Pedigree	**Saaz and New Zealand selection**
Aroma	**“Noble” with citrus and fruity**
Alpha Acids*	**6.5 - 7.5 %**
Beta Acids	**5.0 - 5.5 %**
Cohumulone	**28 - 30 % of alpha acids**
Total Oil	**0.6 - 1.0 ml/100g**
Myrcene	**45 - 50 % of total oil**
Humulene	**2 - 6 % of total oil**
Caryophyllene	**1 - 3 % of total oil**
Farnesene	**10 - 14 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Mount Hood

U.S.
Aroma hop

Mt. Hood is an aroma variety released in 1989 from the USDA breeding program in Oregon. The variety is a triploid daughter of Hallertau Mittelfrüh and a sister to Liberty, with analytical data similar to both. It has low alpha acids and beta acids content, low cohumulone, and high humulene in the essential oil. Mount Hood exhibits a pleasant, mild aroma.

Pedigree	**Triploid daughter of Hallertau Mittelfrüh**
Aroma	**Mild, herbal, somewhat pungent**
Alpha Acids*	**4.0 - 7.0 %**
Beta Acids	**5.0 - 8.0 %**
Cohumulone	**21 - 23 % of alpha acids**
Total Oil	**1.2 - 1.7 ml/100g**
Myrcene	**30 - 40 % of total oil**
Humulene	**30 - 38 % of total oil**
Caryophyllene	**13 - 16 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Poor**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Mount Rainier

U.S.
Dual Purpose Hop

Mt. Rainier was released in 2008 through the USDA hop breeding program at Oregon State University. It is the daughter of German Magnum and a USDA male hop. Mt. Rainier's aroma is similar to the classic floral, herbal and spicy characteristic found in German Hallertau Mittelfrüh. It is also described as having a hint of licorice. The higher alpha content makes it a dual purpose hop.

Pedigree	German Magnum and USDA Male
Aroma	Mild, floral, herbal, spicy
Alpha Acids*	8.0 - 10.8 %
Beta Acids	7.6 - 9.3 %
Cohumulone	21 - 23 % of alpha acids
Total Oil	1.8 - 2.7 ml/100g
Myrcene	61 - 71 % of total oil
Humulene	16 - 21 % of total oil
Caryophyllene	4.6 - 6.6 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Nelson Sauvin

New Zealand Aroma Hop

Nelson Sauvin is a triploid dual purpose variety developed through the HortResearch hop breeding program in New Zealand. It was bred from the New Zealand variety "Smoothcone" and released in 2000. The variety is known for its white-wine "fruitiness" character that is very noticeable and distinctive in beer.

Pedigree	**Triploid from NZ Smoothcone**
Aroma	**Unique fruity, white wine**
Alpha Acids*	**12.0 - 13.0 %**
Beta Acids	**6.0 - 8.0 %**
Cohumulone	**22 - 26 % of alpha acids**
Total Oil	**1.0 - 1.2 ml/100g**
Myrcene	**21 - 23 % of total oil**
Humulene	**35 - 37 % of total oil**
Caryophyllene	**10 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Newport

U.S.
High Alpha Hop

Newport was developed through the USDA program at Oregon State University as a multiple disease resistant, high alpha and beta bittering hop, released in 2002. It is a descendant from a cross of Hallertauer "Magnum" and USDA male 58111. Newport has excellent yields and is resistant to both powdery and downy mildews.

Pedigree	Daughter of Magnum
Aroma	Mild
Alpha Acids*	13.5 - 17.0 %
Beta Acids	7.2 - 9.1 %
Cohumulone	36 - 38 % of alpha acids
Total Oil	1.6 - 3.4 ml/100g
Myrcene	47 - 54 % of total oil
Humulene	9 - 14 % of total oil
Caryophyllene	4 - 7 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Northdown

U.K.

Dual Purpose Hop

Northdown was developed at Wye College in the UK from a cross of Northern Brewer female with a German male hop; released in the early 1970s. It is a high yielding, dual purpose variety with good resistance to downy mildew but is susceptible to powdery mildew. Northdown has a distinctive aroma including notes of spicy, pine, floral and berry.

Pedigree	**Northern Brewer and German male hop**
Aroma	**Spicy, pine, floral and berry**
Alpha Acids*	**7.0 - 10.0 %**
Beta Acids	**4.0 - 5.0 %**
Cohumulone	**29 - 33 % of alpha acids**
Total Oil	**1.2 - 2.2 ml/100g**
Myrcene	**23 - 27 % of total oil**
Humulene	**35 - 39 % of total oil**
Farnesene	**1 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Northern Brewer

U.K.

Dual Purpose Hop

Bred in England in 1934, this variety was developed specifically for Scottish & Newcastle Breweries and originally grown in the North of England - hence its name. It has a high alpha content and is currently one of the main varieties in the German Hallertau region, where it has developed good aroma qualities by adapting to climate and soil. Northern Brewer is wilt-resistant.

Pedigree	**Canterbury Golding crossed with male seedling of Brewers Gold**
Aroma	**Medium intensity with pine and minty notes**
Alpha Acids*	**6.0 - 10.0 %**
Beta Acids	**3.0 - 5.0 %**
Cohumulone	**27 - 32 % of alpha acids**
Total Oil	**1.0 - 1.6 ml/100g**
Myrcene	**25 - 45 % of total oil**
Humulene	**35 - 50 % of total oil**
Caryophyllene	**10 - 20 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Nugget

U.S.
High Alpha Hop

Nugget is a high alpha variety with high yield originally developed through the USDA program at Oregon State University from a cross made in 1970 and registered much later in 1984. The variety is tolerant to a wide range of soil conditions and thus grows vigorously in all areas. Nugget is also grown in the German Hallertau region but produces somewhat lower alpha content there.

Pedigree	**Daughter of Brewers Gold**
Aroma	**Mild, pleasant herbal**
Alpha Acids*	**11.5 - 14.0 %**
Beta Acids	**3.0 - 5.0 %**
Cohumulone	**22 - 30 % of alpha acids**
Total Oil	**0.9 - 1.3 ml/100g**
Myrcene	**27 - 42 % of total oil**
Humulene	**16 - 19 % of total oil**
Caryophyllene	**7 - 10 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Very good to excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Oktawia

Poland

Bitter Hop

Oktawia is a bitter hop released in 1996. It was bred by hybridization of progenies of Brewers Gold and Northern Brewer. Oktawia is a mid-range alpha hop with some floral and resinous aroma character and is grown in limited quantities in Poland.

Pedigree	Bred from Brewers Gold and Northern Brewer
Aroma	Floral and resinous
Alpha Acids*	7.0 - 9.0 %
Beta Acids	3.0 - 4.5 %
Cohumulone	33 - 37 % of alpha acids
Total Oil	0.7 - 1.4 ml/100g
Myrcene	30 - 50 % of total oil
Humulene	36 - 40 % of total oil
Caryophyllene	6 - 8 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Opal

Germany

Aroma Hop

Opal is a German hop developed at the Hüll Research Center. The hop exhibits excellent aroma characteristics combined with a moderate alpha acid concentration. Opal has a sweet spice, slightly peppery character combined with a light, clean citrus-fruit aromas.

Pedigree	Daughter of Hallertau Gold
Aroma	Spice, pepper, citrus
Alpha Acids*	5.0 - 8.0 %
Beta Acids	3.5 - 5.5 %
Cohumulone	13 - 17 % of alpha acids
Total Oil	0.8 - 1.3 ml/100g
Myrcene	20 - 45 % of total oil
Humulene	30 - 50 % of total oil
Caryophyllene	8 - 15 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pacific Gem

New Zealand
High Alpha Hop

Pacific Gem is a high alpha triploid hop developed through the HortResearch breeding program in New Zealand and released in 1987. It was bred from the NZ variety "Smoothcone" and a Cluster/Fuggle cross. Pacific Gem's aroma is well balanced and pleasant for a high-alpha hop.

Pedigree	**Crosses of Smoothcone, Cluster, and Fuggle**
Aroma	**Pleasant blackberry aroma**
Alpha Acids*	**13.0 - 15.0 %**
Beta Acids	**7.0 - 9.0 %**
Cohumulone	**37 - 40 % of alpha acids**
Total Oil	**1.1 - 1.3 ml/100g**
Myrcene	**32 - 34 % of total oil**
Humulene	**29 - 31 % of total oil**
Caryophyllene	**10 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pacific Jade

New Zealand
Dual Purpose Hop

Pacific Jade is a high-alpha hop variety released from the New Zealand HortResearch program in 2004. It was developed as a cross of First Choice (relative of Late-Cluster) and an "Old Line" Saaz male. Its aroma is described as "bold" with herbal, fresh citrus, with black pepper notes.

Pedigree	**Cross of First Choice and Saaz male**
Aroma	**Herbal, citrus, black pepper**
Alpha Acids*	**12.0 - 14.0 %**
Beta Acids	**7.0 - 8.0 %**
Cohumulone	**22 - 26 % of alpha acids**
Total Oil	**1.0 - 1.5 ml/100g**
Myrcene	**31 - 35 % of total oil**
Humulene	**31 - 35 % of total oil**
Caryophyllene	**8 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pacifica

New Zealand Aroma Hop

Formerly known as Pacific Hallertau, Pacifica is a triploid aroma variety developed through the HortResearch hop breeding program in New Zealand and released in 1994. The hop is said to exhibit a "classic" Hallertau character with some citrus and floral notes.

Pedigree	**Triploid aroma-type; released in 1994**
Aroma	**Citrus and floral**
Alpha Acids*	**5.0 - 6.0 %**
Beta Acids	**5.5 - 6.5 %**
Cohumulone	**24 - 26 % of alpha acids**
Total Oil	**0.9 - 1.1 ml/100g**
Myrcene	**10 - 14 % of total oil**
Humulene	**48 - 52 % of total oil**
Caryophyllene	**16 - 18 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Fair to good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Palisade®

U.S.
Aroma Hop

Palisade® is an aroma variety bred in the U.S. by Yakima Chief Ranches. It is popular in brewing for its aromatic properties and moderate bittering and has good resistance to powdery mildew. Palisade® appears to be named after a hop field enclosure used in cultivation.

Pedigree	Open pollination
Aroma	Mild, pleasant aroma
Alpha Acids*	5.5 - 9.5 %
Beta Acids	6.0 - 8.0 %
Cohumulone	24 - 29 % of alpha acids
Total Oil	1.4 - 1.6 ml/100g
Myrcene	9 - 10 % of total oil
Humulene	19 - 22 % of total oil
Caryophyllene	16 - 18 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pekko™

U.S.
Aroma Hop

Named after the Finnish god of field and crops, Pekko® is a recent release from the American Dwarf Hop Association breeding program in the Yakima Valley. Previously known as ADHA 871, its mother is ADHA 538 with open pollination. Pekko® has a moderately high alpha content with a complex aroma character including floral, fruity, citrus and mint notes.

Pedigree	**ADHA 538, open pollination**
Aroma	**Floral, citrus, mint**
Alpha Acids*	**13.0 - 16.0 %**
Beta Acids	**3.5 - 4.3 %**
Cohumulone	**27 - 30 % of alpha acids**
Total Oil	**2.1 - 2.7 ml/100g**
Myrcene	**46 - 55 % of total oil**
Humulene	**12 - 15 % of total oil**
Caryophyllene	**11 - 13 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Perle

Germany
Aroma Hop

The combination of good alpha acids content with good aroma gave rise to Perle's popularity. High yields and good tolerance to most diseases make this variety attractive also for growers. Released in 1978, it is well established in Germany and also grown in the U.S. in both Washington and Oregon.

Pedigree	Bred from Northern Brewer
Aroma	Herbal, spicy
Alpha Acids*	4.0 - 9.0 %
Beta Acids	2.5 - 4.5 %
Cohumulone	29 - 35 % of alpha acids
Total Oil	0.5 - 1.5 ml/100g
Myrcene	20 - 35 % of total oil
Humulene	35 - 55 % of total oil
Caryophyllene	10 - 20 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good to excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Phoenix

UK

Dual Purpose Hop

Released though the Wye College Horticulture Research program in 1996, Phoenix is a dual purpose variety with a complex aroma described as pine, floral, chocolate, molasses and spicy. It was developed from a seedling of the British hop, Yeoman. Phoenix has excellent tolerance to wilt, resistance to powdery mildew but susceptibility to downy mildew.

Pedigree	**British Yoeman**
Aroma	**Pine, floral, sweet, spicy**
Alpha Acids*	**8.0 - 12.0 %**
Beta Acids	**3.8 - 5.4 %**
Cohumulone	**30 % of alpha acids**
Total Oil	**1.2 - 2.5 ml/100g**
Myrcene	**24 % of total oil**
Humulene	**30 % of total oil**
Farnesene	**1.5 % of total oil**
Storage Stability	**Excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pilgrim

U.K.

Bitter Hop

Pilgrim is a bitter-type variety developed by Wye Hops Ltd. and released in 2001. It has very good resistance to wilt disease and is being planted in areas where this disease is present, often replacing Wye Target. Bred from Yeoman in the late 1990's, Pilgrim is a high alpha dual purpose hop, rich in oils with good storage stability.

Pedigree	**Half-sister to First Gold; mother from Wye Challenger and Target**
Aroma	**Fruity, spicy, lemon, grapefruit**
Alpha Acids*	**9.0 - 13.0 %**
Beta Acids	**4.0 - 5.0 %**
Cohumulone	**32 - 36 % of alpha acids**
Total Oil	**1.0 - 1.8 ml/100g**
Myrcene	**30 - 35 % of total oil**
Humulene	**21 - 25 % of total oil**
Caryophyllene	**6 - 9 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pilot

U.K.

Bitter Hop

Pilot was developed at Wye College in the UK and released in 2001 as a high yielding bitter hop resistant to wilt, but it is susceptible to both downy and powdery mildews. Pilot is distinctively different in aroma from other British hops with notes of lemon and spice, and it is also described as having a marmalade flavor.

Pedigree	Bred at Wye College in 2001 from open pollination of Pioneer
Aroma	Typical English Aroma
Alpha Acids*	8.0 - 11.0 %
Beta Acids	3.3 - 5.0 %
Cohumulone	32 - 37 % of alpha acids
Total Oil	0.8 - 1.5 ml/100g
Myrcene	35 - 40 % of total oil
Humulene	3 - 6 % of total oil
Caryophyllene	3 - 4 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Poor to fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pioneer

U.K.

Dual Purpose Hop

Pioneer is a dwarf dual purpose hop released in 1996 from Wye College in the UK. It has good tolerance to wilt, but is susceptible to both downy and powdery mildews. Pioneer has an assertive aroma which includes a distinctive hoppy but pleasant lemon and grapefruit notes with some cedar and herbal characters present.

Pedigree	**Dwarf variety bred at Wye College in 1996**
Aroma	**Hoppy with lemon/grapefruit; cedar and herbal**
Alpha Acids*	**8.0 - 10.5 %**
Beta Acids	**3.5 - 4.5 %**
Cohumulone	**33 - 40 % of alpha acids**
Total Oil	**1.0 - 1.8 ml/100g**
Myrcene	**28 - 42 % of total oil**
Humulene	**18 - 25 % of total oil**
Caryophyllene	**6 - 9 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Fair to good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Polaris

Germany

Aroma Hop

Polaris is a German variety having an intensive aroma and a refreshing note, described by some as “mint drop”. The variety was bred at the Hüll Research Center and released 2012 in response to demand from the craft beer industry’s desire for bold tastes and differentiating flavors.

Pedigree	Hüll breeding line
Aroma	Floral, mint
Alpha Acids*	18.0 - 23.0 %
Beta Acids	4.5 - 6.0 %
Cohumulone	22 - 28 % of alpha acids
Total Oil	4.0 - 5.0 ml/100g
Myrcene	50 % of total oil
Humulene	20 - 35 % of total oil
Caryophyllene	8 - 13 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Premiant

Czechia

Aroma Hop

Premiant is a Czech dual purpose hop variety selected from hybrid progenies of the Saaz variety and other breeding material. It was registered in 1996 and has a relatively high alpha content and a good agronomic yield. Premiant has a mild and pleasant aroma.

Pedigree	Bred from Saaz
Aroma	Mild and pleasant spicy, fruity
Alpha Acids*	7.0 - 10.0 %
Beta Acids	3.5 - 5.5 %
Cohumulone	18 - 23 % of alpha acids
Total Oil	1.0 - 2.0 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	25 - 40 % of total oil
Caryophyllene	9 - 13 % of total oil
Farnesene	1 - 3 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Pride of Ringwood

Australia
Bitter Hop

Pride of Ringwood was bred by Carlton and United Breweries in 1953 at their Ringwood Research Station Melbourne Victoria. This cultivar was bred by open pollination of a female related to the English cultivar Pride of Kent. It has been commercially grown since the 1960's and is a very well regarded high alpha Australian bred bitter variety with pleasant hop aroma.

Pedigree	Selected in Australia from Pride of Kent
Aroma	Assertive but pleasant herbal
Alpha Acids*	8.6 - 11.0 %
Beta Acids	4.0 - 8.0 %
Cohumulone	25 - 34 % of alpha acids
Total Oil	1.0 - 2.0 ml/100g
Myrcene	30 - 41 % of total oil
Humulene	1.6 - 3.0 % of total oil
Caryophyllene	10 - 12 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Progress

U.K.

Dual Purpose Hop

Progress was developed at Wye College and released for commercial growing in 1964. It is somewhat similar to a Fuggle but slightly sweeter aroma. Progress has an aroma profile and alpha level ideally suited to British Bitter, Pale Ales, Porter & Stout.

Pedigree	Daughter of Whitbread Golding crossed with a wild American male hop
Aroma	Moderate hop aroma, sweet
Alpha Acids*	6.0 - 7.5 %
Beta Acids	2.0 - 3.3 %
Cohumulone	30 - 35 % of alpha acids
Total Oil	0.8 - 1.0 ml/100g
Myrcene	28 - 30 % of total oil
Humulene	36 - 42 % of total oil
Caryophyllene	12 - 15 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Relax

Germany
Aroma Hop

Originally bred as a hop for tea, Relax is essentially a no-alpha hop with high beta. Developed from a breeding line from the Hüll Research Center in Germany, it provides a highly complex and favorable aroma contribution to beer. The broad range of flavors include corn flower, hibiscus, “alpine meadow”, lemongrass, green tea and some honeydew melon.

Aroma	Floral, lemongrass, tea, melon
Alpha Acids*	< 0.5 %
Beta Acids	10 - 15 %
Total Oil	1.0 - 1.3 ml/100g

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Riwaka

New Zealand Aroma Hop

Riwaka was developed from the same HortResearch breeding program in New Zealand that brought about the Motueka variety. Riwaka was released in 1997 and is a cross of “Old Line” Saaz with specially developed New Zealand breeding selections. It has a strong grapefruit aroma.

Pedigree	Saaz and New Zealand breeding selections
Aroma	Strong grapefruit, citrus
Alpha Acids*	4.5 - 6.5 %
Beta Acids	4.0 - 5.0 %
Cohumulone	34 - 38 % of alpha acids
Total Oil	1.2 - 1.7 ml/100g
Myrcene	65 - 70 % of total oil
Humulene	8 - 10 % of total oil
Caryophyllene	2 - 6 % of total oil
Farnesene	1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Rubin

Czechia

Bitter Hop

Released in 2007, Rubin is a bitter variety with genetic similarities to the European aroma hops Saaz and Northern Brewer, from which it is derived. Along with its high alpha content, Rubin exhibits a fine spicy aroma characteristic. The name is derived from the color of the hop bine.

Pedigree	Selected from hybrid progenies of Bor, Saaz and Northern Brewer
Aroma	Spicy, herbal
Alpha Acids*	9.0 - 12.0 %
Beta Acids	3.5 - 5.0 %
Cohumulone	25 - 33 % of alpha acids
Total Oil	1.0 - 2.0 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	15 - 25 % of total oil
Caryophyllene	7 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Saaz

Czechia
Aroma Hop

Saaz is the famous aroma landrace variety originating in the Czech area of the same name and is considered by many as the world standard for a fine noble aroma hop. It has very mild, pleasant spicy, citrus and herbal hoppy notes perfectly suited for and defines Czech-style pilsner beers. Since 1952, Saaz has been cultivated into nine separate clones, the last being in 1993.

Pedigree	Czech landrace variety
Aroma	Classic noble aroma with spicy, citrus, herbal
Alpha Acids*	2.5 - 4.5 %
Beta Acids	4.0 - 6.0 %
Cohumulone	23 - 26 % of alpha acids
Total Oil	0.4 - 0.8 ml/100g
Myrcene	25 - 40 % of total oil
Humulene	15 - 30 % of total oil
Caryophyllene	6 - 9 % of total oil
Farnesene	14 - 20 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Saaz Late

Czechia

Aroma Hop

Saaz Late is a Czech selection from progenies of a combination of developed breeding material with its origin in the Saaz region. The variety was released 2010 from the Hop Research Institute Co., Ltd. in Czechia. It has good yield and fungus resistance.

Pedigree	Cross between Saaz and Sládek cultivars
Aroma	Floral, fruity, spicy
Alpha Acids*	3.5 - 6.0 %
Beta Acids	4.0 - 6.5 %
Cohumulone	20 - 25 % of alpha acids
Total Oil	0.5 - 1.0 ml/100g
Myrcene	25 - 35 % of total oil
Humulene	15 - 25 % of total oil
Caryophyllene	6 - 9 % of total oil
Farnesene	15 - 20 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Santiam

U.S.
Aroma Hop

Santiam is an American aroma hop that contains noble hop characteristics similar to German grown Tettnanger. Released in 1997, this hop has noble-type characteristics with high farnesene and floral with peppery spice aroma notes. It is tolerant to downy mildew but susceptible to powdery mildew.

Pedigree	Triploid selection from Tettnanger, Hallertau MF and triploid USDA male
Aroma	Herbal, noble-type
Alpha Acids*	5.5 - 7.0 %
Beta Acids	7.0 - 8.5 %
Cohumulone	20 - 22 % of alpha acids
Total Oil	1.3 - 1.7 ml/100g
Myrcene	30 - 45 % of total oil
Humulene	20 - 25 % of total oil
Caryophyllene	5 - 8 % of total oil
Farnesene	13 - 16 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Saphir

Germany

Aroma Hop

Saphir is a very fine aroma variety, with average bitter value and storage characteristics. It was developed at the Hop Research Center in Hüll, Germany and released in 2002.

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Pedigree	Bred at Hop Research Center in Hüll Germany
Aroma	Spicy, fruity, floral
Alpha Acids*	2.0 - 4.5 %
Beta Acids	4.0 - 7.0 %
Cohumulone	12 - 17 % of alpha acids
Total Oil	0.8 - 1.4 ml/100g
Myrcene	25 - 40 % of total oil
Humulene	20 - 30 % of total oil
Caryophyllene	9 - 14 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Simcoe®

U.S.
Dual Purpose Hop

Simcoe® is a Dual Purpose hop bred by Yakima Chief Ranches in Yakima, Washington, released and trademarked in 2000. It has a distinctive pine-like aroma with citrus overtones and also has a high alpha content. The variety is very popular with American craft brewers.

Pedigree	**Open pollination**
Aroma	**Citrus and unique pine-like**
Alpha Acids*	**12.0 - 14.0 %**
Beta Acids	**4.0 - 5.0 %**
Cohumulone	**15 - 20 % of alpha acids**
Total Oil	**2.0 - 2.5 ml/100g**
Myrcene	**60 - 65 % of total oil**
Humulene	**10 - 15 % of total oil**
Caryophyllene	**5 - 8 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sládek

Czechia

Aroma Hop

Registered in 1994, Sládek is a hybrid aroma variety of Saaz-type with excellent impact on hoppy taste and aroma of beer. It is a late harvest variety with high yield. Sládek is reported to be a good complement to Saaz in a late-hopping regime.

Pedigree	**Saaz-type with Northern Brewer**
Aroma	**Noble-aroma spicy and fruity**
Alpha Acids*	**4.5 - 8.0 %**
Beta Acids	**4.0 - 7.0 %**
Cohumulone	**23 - 30 % of alpha acids**
Total Oil	**1.0 - 2.0 ml/100g**
Myrcene	**35 - 50 % of total oil**
Humulene	**20 - 40 % of total oil**
Caryophyllene	**9 - 14 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Smaragd

Germany
Aroma Hop

Smaragd is a tough to pronounce but fine German aroma variety with high bitter value. It has good disease resistance characteristics but some susceptibility to powdery mildew. Smaragd shows high yields and good production characteristics. The variety was developed at the Hop Research Center at Hüll Germany.

Pedigree	Daughter of Hallertau Gold
Aroma	Floral, spicy, mild fruity
Alpha Acids*	4.0 - 6.0 %
Beta Acids	3.5 - 5.5 %
Cohumulone	13 - 18 % of alpha acids
Total Oil	0.4 - 0.8 ml/100g
Myrcene	20 - 40 % of total oil
Humulene	30 - 50 % of total oil
Caryophyllene	9 - 14 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sorachi Ace

Japan

Dual Purpose Hop

Sorachi Ace was developed in 1984 for Sapporo Breweries Ltd. from a cross of Brewer's Gold, Saaz, and male Beikei No. 2. The name “Sorachi” is derived from a sub-prefecture of Hokkaido, Japan. This variety has a good yield, good resistance to mildew, wilt and botrytis. It has a rather high alpha and oil content. The variety is currently grown in limited quantities in the U.S.

Pedigree	**Brewers Gold, Saaz, male Beikei**
Aroma	**Pleasant lemon character**
Alpha Acids*	**12.0 - 16.0%**
Beta Acids	**6.0 - 7.0 %**
Cohumulone	**20 - 25 % of alpha acids**
Total Oil	**2.0 - 3.0 ml/100g**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Southern Brewer

South Africa
Bitter Hop

Southern Brewer was the first successful hop developed from the African Breweries Hops Farms Ltd. in 1972 as a variety better adapted to the shorter summer daytime length in South Africa. It is considered a bitter hop with no outstanding aroma qualities.

Pedigree	Diploid seedling selected from Fuggle crosses
Alpha Acids*	8 - 12 %
Beta Acids	2.5 - 5.0 %
Cohumulone	38 - 41 % of alpha acids
Total Oil	0.4 - 1.5 ml/100g
Myrcene	50 - 60 % of total oil
Humulene	9 - 20 % of total oil
Caryophyllene	4 - 10 % of total oil
Farnesene	3 - 11 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Southern Cross

New Zealand
Dual Purpose Hop

Southern Cross is a triploid New Zealand variety released through the HortResearch hop breeding program in 1994, derived from Smoothcone and a 1950s research variety originating from North American “Cali” and Fuggle. It is a high alpha variety that contributes a citrus, lemon zest character along with some pine notes. The hop is known for its early vigorous growth.

Pedigree	Smoothcone with N. American “Cali”, Fuggle
Aroma	Citrus lemon zest, pine
Alpha Acids*	11 - 14 %
Beta Acids	5 - 6 %
Cohumulone	25 - 28 % of alpha acids
Total Oil	1.0 - 1.5 ml/100g
Myrcene	30 - 35 % of total oil
Humulene	19- 22 % of total oil
Caryophyllene	6 - 7 % of total oil
Farnesene	7 - 8 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Southern Dawn

South Africa
Dual Purpose Hop

Southern Dawn is a South African cultivar used by the largest South African breweries. It is used both as an aroma and bitter variety. Southern Dawn resembles Southern Promise to a certain extent but has a different aroma expression.

Pedigree	**Southern Brewer X OJA1/112**
Aroma	**Fruity and spicy**
Alpha Acids*	**11.2 - 12.5 %**
Beta Acids	**4.3 - 5.9 %**
Total Oil	**0.6 - 1.0 ml/100g**
Myrcene	**21 - 44 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Southern Promise

South Africa
Dual Purpose Hop

Southern Promise was released in South Africa in 1992 as a variety adapted to the short day-length in the southern tip of Africa. It is a cross of Southern Brewer and a Slovenian male variety. Southern Promise is relatively high in alpha with good aromatic qualities.

Pedigree	Diploid seedling from Southern Brewer and wild Slovenian male hop
Aroma	Herbal, fruity
Alpha Acids*	9.5 - 11.5%
Beta Acids	3.6 - 5.4 %
Cohumulone	20 - 22 % of alpha acids
Total Oil	0.7 - 1.1 ml/100g
Myrcene	20 - 23 % of total oil
Humulene	22 - 28 % of total oil
Caryophyllene	8 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Southern Star

South Africa

Dual Purpose Hop

Southern Star was released in 2001 in South Africa as a variety adapted to the region's short day-length and is a cross between Outeniqua and a South African male variety. It is high in alpha for a variety grown in the area and has a relatively high farnesene content. The hop has been described as having a subtle spicy aroma.

Pedigree	Diploid seedling of Outeniqua and South African male variety
Aroma	Hoppy, subtle spicy
Alpha Acids*	12.0 - 15.5 %
Beta Acids	4.8 - 5.2 %
Cohumulone	28 - 33 % of alpha acids
Total Oil	1.3 - 1.6 ml/100g
Myrcene	30 - 38 % of total oil
Humulene	18 - 24 % of total oil
Caryophyllene	12 - 16 % of total oil
Farnesene	10 - 14 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sovereign

U.K.

Aroma Hop

This variety is a dwarf hop released from Wye College in 2004 from a cross pollination of WGV with dwarf male. Sovereign shows a complex English-type flavor and aroma described as a delicate combination of floral, grassy and herbal with a hint of mint.

Pedigree	**Dwarf variety bred at Wye College in 1995 from open pollination**
Aroma	**Complex floral, grassy, herbal and mint**
Alpha Acids*	**4.5 - 6.5 %**
Beta Acids	**2.1 - 3.1 %**
Cohumulone	**25 - 30 % of alpha acids**
Total Oil	**0.5 - 1.0 ml/100g**
Myrcene	**25 - 30 % of total oil**
Humulene	**21 - 26 % of total oil**
Caryophyllene	**7 - 10 % of total oil**
Farnesene	**3 - 5 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Spalt Spalter

Germany

Aroma Hop

Spalt variety has a very fine aroma and is comparable to German Tettnanger. The locally grown Spalt variety belongs to the Saaz range and is cultivated exclusively in the region around Spalt. Despite its sometimes less than satisfactory yields, this variety is popular for lager style beers. Spalt Spalter has good resistance to wilt and other diseases.

Pedigree	German landrace variety
Aroma	Traditional fine noble aroma
Alpha Acids*	2.5 - 5.5 %
Beta Acids	3.0 - 5.0 %
Cohumulone	22 - 29 % of alpha acids
Total Oil	0.5 - 0.9 ml/100g
Myrcene	20 - 35 % of total oil
Humulene	20 - 30 % of total oil
Caryophyllene	8 - 13 % of total oil
Farnesene	12 - 18 % of total oil
Storage Stability	Poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Spalter Select

Germany

Aroma Hop

Spalter Select was bred at Hüll Hop Research Center and its fine aroma and high farnesene content are typical of Spalt-type hops. This variety grows quickly and develops a very strong "head". Spalter Select is characterized by a good tolerance to diseases like wilt and downy mildew.

Pedigree	Hüll breeding material
Aroma	Spalt-like; spicy, floral
Alpha Acids*	3.0 - 6.5 %
Beta Acids	2.5 - 5.0 %
Cohumulone	21 - 27 % of alpha acids
Total Oil	0.6 - 0.9 ml/100g
Myrcene	20 - 40 % of total oil
Humulene	10 - 22 % of total oil
Caryophyllene	4 - 10 % of total oil
Farnesene	15 - 22 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sterling

U.S.
Aroma Hop

Sterling is an aroma cultivar derived from diploid seedling from cross of Saaz and a number of other varieties including Cascade, Brewers Gold, Early Green and German open-pollination. Released in 1998, Sterling is moderately resistant to downy and powdery mildews.

Pedigree	Mostly Saaz and Cascade
Aroma	Herbal, spicy, hint of floral-citrus
Alpha Acids*	6.0 - 9.0 %
Beta Acids	4.0 - 6.0 %
Cohumulone	22 - 28 % of alpha acids
Total Oil	1.3 - 1.9 ml/100g
Myrcene	44 - 48 % of total oil
Humulene	19 - 23 % of total oil
Caryophyllene	5 - 7 % of total oil
Farnesene	11 - 17 % of total oil
Storage Stability	Fair to good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Stricklebract

New Zealand
High Alpha Hop

Released in 1972 from the New Zealand Horticultural Research Center at Riwaka, Stricklebract is a triploid variety derived from the open pollination of the New Zealand diploid cultivar First Choice. It is a high alpha hop but its aroma has been characterized as citrus and pine needles.

Pedigree	Open Pollination of First Choice
Aroma	Citrus, pine
Alpha Acids*	11 - 14 %
Beta Acids	6 - 7 %
Cohumulone	36 - 40 % of alpha acids
Total Oil	0.6 - 1.0 ml/100g
Myrcene	14 - 16 % of total oil
Humulene	23 - 27 % of total oil
Caryophyllene	11 - 14 % of total oil
Farnesene	6 - 8 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Strisselspalt

France

Aroma Hop

Strisselspalt is a major aroma hop of the Alsace area of France near Strasbourg. It has a medium intensity, pleasant herbal aroma and is a fine example of a noble-aroma type hop from Europe. Strisselspalt has low cohumulone and typically a very low alpha content.

Pedigree	European Land Variety
Aroma	Medium intense pleasant herbal
Alpha Acids*	1.8 - 2.5 %
Beta Acids	3.0 - 6.0 %
Cohumulone	22 - 25 % of alpha acids
Total Oil	0.6 - 0.8 ml/100g
Myrcene	35 - 52 % of total oil
Humulene	15 - 25 % of total oil
Caryophyllene	8 - 10 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Styrian Gold

Slovenia

Aroma Hop

Styrian Gold was bred to improve the agronomic values of the traditional Savinjski Golding and was released in 2009. Though named Styria (Austria), the variety is cultivated mainly in Slovenia. Styrian Gold is a very popular variety due to its characteristic aroma and average alpha values.

Pedigree	Daughter of Savinjski Golding
Aroma	Spicy noble aroma
Alpha Acids*	3.5 - 6.5 %
Beta Acids	3.5 - 5.9 %
Total Oil	1.3 - 2.3 ml/100g
Myrcene	38 - 47 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Styrian Savinjski Golding

Slovenia

Aroma Hop

Styrian Savinjski Golding is a traditional Slovenian variety originating from the English variety Fuggle, which was brought to Slovenia in the early 19th century. This variety is known for its noble hop aroma and pleasant bitterness.

Pedigree	Daughter of Fuggle
Aroma	Delicate, slightly spicy noble aroma
Alpha Acids*	4.5 - 6.0 %
Beta Acids	2.5 - 3.5 %
Cohumulone	25 - 30 % of alpha acids
Total Oil	0.5 - 1.0 ml/100g
Myrcene	27 - 33 % of total oil
Humulene	34 - 38 % of total oil
Caryophyllene	9 - 11 % of total oil
Farnesene	2 - 5 % of total oil
Storage Stability	Very good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Summit™

U.S.
High Alpha Hop

Summit is a dwarf high-alpha variety bred by the American Dwarf Hop Association in the U.S. Released in 2003, it has unusually high alpha acids content, excellent storage stability and powdery mildew resistance. Summit has a strong aroma profile which includes citrus and grapefruit notes.

Pedigree	**From Nugget crossed with progeny of female Zeus and USDA males**
Aroma	**Strong citrus and grapefruit**
Alpha Acids*	**16.0 - 18.0 %**
Beta Acids	**4.0 - 6.0 %**
Cohumulone	**26 - 33 % of alpha acids**
Total Oil	**1.5 - 2.5 ml/100g**
Myrcene	**35 - 50 % of total oil**
Humulene	**15 - 25 % of total oil**
Caryophyllene	**10 - 15 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Super Galena™

U.S.
High Alpha Hop

Super Galena is a super high alpha variety developed by the Hopsteiner breeding program and released in 2006. It has relatively high content of both alpha and beta acids; a good bittering hop with pleasant aroma. Super Galena offers a high yield and resistance to powdery mildew.

Pedigree	Open pollination of Galena
Aroma	Similar to Galena
Alpha Acids*	13.0 - 16.0 %
Beta Acids	8.0 - 10.0 %
Cohumulone	35 - 40 % of alpha acids
Total Oil	1.5 - 2.5 ml/100g
Myrcene	45 - 60 % of total oil
Humulene	19 - 24 % of total oil
Caryophyllene	6 - 14 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Super Pride

Australia
Bitter Hop

The Australian Super Pride is a seedless bittering variety with moderately high levels of alpha acids. It was bred at Rostrevor Hop Gardens in Australia. Derived from the famous Pride of Ringwood, it has been the backbone of Australia's bittering since the late 1990s. This cultivar features mild aroma and relatively low cohumulone.

Pedigree	**Pride of Ringwood and UK male**
Aroma	**Pleasant mild herbal aroma**
Alpha Acids*	**13.0 - 15.5 %**
Beta Acids	**4.5 - 8.0 %**
Cohumulone	**24 - 31 % of alpha acids**
Total Oil	**1.4 - 2.8 ml/100g**
Myrcene	**24 - 44 % of total oil**
Humulene	**1 - 2 % of total oil**
Caryophyllene	**3 - 9 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sussex

U.K.

Aroma Hop

Sussex is derived from a chance seedling found in a hedgerow in 2005 at a hop farm owned by the Cyster family in Gate Court, Northiam. Analyses show it to be unlike any known commercial variety and is likely to be a result of open pollination in the wild. Sussex is robust, has a very good yield, is easy to grow with good resistance to most pests. Its aroma is described as earthy, grassy and minty.

Pedigree	UK wild hop
Aroma	Earthy, grassy, mint
Alpha Acids*	4.3 - 5.8 %
Beta Acids	2.4 - 3.2 %
Cohumulone	29 - 32 % of alpha acids
Total Oil	0.4 - 0.6 ml/100g
Myrcene	40 - 44 % of total oil
Humulene	21 - 24 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Sybilla

Poland

Dual Purpose Hop

Sybilla is a Polish hop derived from a cross of Lubelski and Slovenian Styrian Golding. It was released by IUNG Pulawy in 1996 and in the years 2004-2006, hop latent viroid free seedlings of Sybilla were produced. Its aroma is described as mild and distinctive.

Pedigree	Bred from Lubelski and Styrian Golding
Aroma/Flavor	Mild and distinctive
Alpha Acids*	6.5 - 8.0 %
Beta Acids	3.0 - 5.0 %
Cohumulone	26 - 31 % of alpha acids
Total Oil	1.2 - 2.1 ml/100g
Myrcene	30 - 50 % of total oil
Humulene	40 - 45 % of total oil
Caryophyllene	9 - 11 % of total oil
Farnesene	6 - 9 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Tahoma

U.S.
Aroma Hop

This is a USDA aroma variety developed though Washington State University and released in 2013. A daughter of Glacier, Tahoma has moderate alpha, very low cohumulone and a pleasant lemon citrus aroma character.

Pedigree	Daughter of Glacier
Aroma	Lemon citrus
Alpha Acids*	7.2 - 8.2 %
Beta Acids	8.5 - 9.5 %
Cohumulone	15 - 17 % of alpha acids
Total Oil	1.0 - 2.0 ml/100g
Myrcene	67 - 72 % of total oil
Humulene	9.0 - 11.0 % of total oil
Caryophyllene	2.9 - 3.5 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Target

U.K.
Bitter Hop

Bred at Wye College in the UK, Target was released in 1972 and is a widely grown British hop. It has a high bitter value, and an intense aroma. Target is a flexible hop that may be used to effectively bitter a wide variety of both Ales and Lagers. Target has a high tolerance to wilt and resistance to powdery mildew but is susceptible to downy mildew.

Pedigree	**Bred from Challenger**
Aroma	**Intense, pleasant English aroma**
Alpha Acids*	**8.5 - 13.5 %**
Beta Acids	**4.0 - 5.7 %**
Cohumulone	**35 - 40 % of alpha acids**
Total Oil	**1.2 - 1.8 ml/100g**
Myrcene	**42 - 50 % of total oil**
Humulene	**15 - 20 % of total oil**
Caryophyllene	**8 - 12 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Poor to very poor**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Taurus

Germany
High Alpha Hop

Taurus is a high alpha German variety bred at the Hüll Research Center. It has a noble, aromatic bitter quality with small and very compact cones which allow clean, mechanical picking and easy drying of the hop. Although not known for its aroma, Taurus has been described as having a noble, aromatic character.

Pedigree	Hüll breeding material
Aroma	Noble, aromatic
Alpha Acids*	12.0 - 17.0 %
Beta Acids	4.0 - 6.0 %
Cohumulone	20 - 25 % of alpha acids
Total Oil	0.9 - 1.4 ml/100g
Myrcene	30 - 50 % of total oil
Humulene	23 - 33 % of total oil
Caryophyllene	6 - 11 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Tettnanger

Germany

Aroma Hop

The Tettnanger variety is a traditional and indigenous hop from the Saaz group which is mainly cultivated around Tettnanger on Lake Constance Germany. The unique combination of the favorable climate at Lake Constance and sandy clay soils from the Ice-age produces a very fine aroma. This variety has a good tolerance to plant diseases. Tettnanger is widely used in lager beer styles.

Pedigree	**Traditional German landrace variety**
Aroma	**Mild and pleasant; slightly spicy**
Alpha Acids*	**2.5 - 5.5 %**
Beta Acids	**3.0 - 5.0 %**
Cohumulone	**22 - 28 % of alpha acids**
Total Oil	**0.5 - 0.9 ml/100g**
Myrcene	**20 - 35 % of total oil**
Humulene	**22 - 32 % of total oil**
Caryophyllene	**6 - 11 % of total oil**
Farnesene	**16 - 24 % of total oil**
Storage Stability	**Poor**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Tomahawk®

U.S.
High Alpha Hop

The current CTZ super high alpha varieties, which include the names Columbus, Tomahawk® and Zeus have the same female parent as Nugget, making them at least half sisters to Nugget. The CTZ varieties are currently used extensively for beer bittering. CTZ's have very poor storage characteristics and are susceptible to mildews

Pedigree	Same female parent as Nugget
Aroma	Aromatic, pungent
Alpha Acids*	15.0 - 17.0 %
Beta Acids	4.5 - 5.0 %
Cohumulone	28 - 32 % of alpha acids
Total Oil	2.5 - 3.5 ml/100g
Myrcene	50 - 60 % of total oil
Humulene	12 - 18 % of total oil
Caryophyllene	9 - 11 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Topaz™

Australia
Dual Purpose Hop

Topaz was originally selected as a seedless high alpha hop, but recent work has shown it to have excellent flavor potential. Topaz can provide earthy notes similar in character to English cultivars, and fruit flavors including lychee can be detected from late-hop additions and higher gravity brews.

Pedigree	Australian high-alpha female and UK male
Aroma/Flavor	Fruity and pleasant
Alpha Acids*	13.8 - 18.0 %
Beta Acids	5.0 - 8.3 %
Cohumulone	45 - 53 % of alpha acids
Total Oil	0.7 - 2.2 ml/100g
Myrcene	33 - 56 % of total oil
Humulene	10 - 16 % of total oil
Caryophyllene	6 - 13 % of total oil
Farnesene	< 1 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Tradition

Germany
Aroma Hop

Tradition is a variety bred at Hüll which is characterized by its fine aroma and elevated bitter content. It can be compared to Hallertauer Mittelfrüh and stands out due to good yields which remain relatively stable even in difficult growing years. This variety has a good tolerance to wilt and downy mildew.

Pedigree	**Daughter of Hallertau Gold**
Aroma	**Noble-type with fruity notes**
Alpha Acids*	**4.0 - 7.0 %**
Beta Acids	**3.0 - 6.0 %**
Cohumulone	**24 - 30 % of alpha acids**
Total Oil	**0.5 - 1.0 ml/100g**
Myrcene	**17 - 32 % of total oil**
Humulene	**35 - 50 % of total oil**
Caryophyllene	**10 - 15 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Triple Pearl

U.S.
Aroma Hop

Released by the USDA-ARS breeding program in 2013, Triple Pearl is a daughter of a triploid Perle mother and unknown diploid male. The lineage includes Northern Brewer and Hallertau. Triple Pearl is similar to its German counterpart, Perle, but has a more pronounced aroma with citrus, spicy, pine and tropical fruit characters.

Pedigree	Triploid Daughter of Perle
Aroma	Citrus, spicy, tropical fruit, pine
Alpha Acids*	10.3 – 11.2 %
Beta Acids	3.3 – 4.2 %
Cohumulone	39 - 55 % of alpha acids
Total Oil	1.1 - 1.8 ml/100g
Humulene	7 - 11 % of total oil
Caryophyllene	3 - 5 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Triskel

France

Aroma Hop

Triskel is a French hop cutivar with an aroma similar to Strisselspalt, from which Triskel inherited its floral notes, but is slightly fruitier. High content of essential oils make Triskel very suitable for late and dry hopping, contributing a pleasant and well-balanced bitter character. The name ''Triskel'' was inspired by triskelion, the symbol of the Gauls, ancestors of the modern French people.

Pedigree	Cross between Strisselspalt and male English Yeoman
Aroma	Floral and fruity
Alpha Acids*	8.0 - 9.0 %
Beta Acids	4.0 - 4.7 %
Cohumulone	20 - 23 % of alpha acids
Total Oil	1.5 - 2.0 ml/100g
Myrcene	60 % of total oil
Humulene	10 - 15 % of total oil

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Tsingdao Flower

China

Dual Purpose Hop

Tsingdao Flower is a Chinese version of the U.S. Cluster variety, therefore sharing many of Cluster's characteristics. It is the principal hop grown in China.

Pedigree	Chinese Cluster
Aroma	Floral, spicy
Alpha Acids*	6.0 - 8.0 %
Beta Acids	3.0 - 4.2 %
Cohumulone	35 % of alpha acids
Total Oil	0.4 - 0.8 ml/100g
Myrcene	45 - 55 % of total oil
Humulene	15 - 18 % of total oil
Caryophyllene	6 - 7 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Ultra

U.S.
Aroma Hop

Ultra was bred through the USDA Oregon State University hops research program in 1983 and is a triploid variety derived from a tetraploid Hallertau Mittelfrüh and a Saaz-type male diploid genotype. It is half-sister to Mt. Hood, Liberty and Crystal. Released in 1995, Ultra has lower alpha than many U.S. aroma varieties.

Pedigree	**Triploid seedling of Hallertau**
Aroma	**Mild and pleasant; Saaz-like**
Alpha Acids*	**2.0 - 3.5 %**
Beta Acids	**3.0 - 4.5 %**
Cohumulone	**23 - 38 % of alpha acids**
Total Oil	**0.5 - 1.0 ml/100g**
Myrcene	**15 - 25 % of total oil**
Humulene	**35 - 50 % of total oil**
Caryophyllene	**10 - 15 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Good to very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Vanguard

U.S.
Aroma Hop

Vanguard was developed from a diploid seedling from Hallertau Mittelfrueh and both USDA male and female crosses. The variety was released in 1997. Its herbal aroma has been likened somewhat to Hallertau Mittelfrüh.

Pedigree	Cross between Hallertau MF and USDA male hop
Aroma	Herbal similar to Hallertau MF
Alpha Acids*	5.5 - 6.0 %
Beta Acids	6.0 - 7.0 %
Cohumulone	14 - 16 % of alpha acids
Total Oil	0.9 - 1.2 ml/100g
Myrcene	20 - 25 % of total oil
Humulene	45 - 50 % of total oil
Caryophyllene	12 - 14 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very good to excellent

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Vic Secret™

Australia
Aroma Hop

Developed in the Hop Products Australia breeding program (part of Barth-Haas Group), Vic Secret was released in 2013. Vic Secret shows distinctive and pleasant pine and fruity flavor characteristics. It is a sister of Topaz, derived from a cross of an Australian female and a UK male.

Pedigree	**Australian high-alpha female and UK male**
Aroma/Flavor	**Pleasant pine, tropical fruits & pineapple**
Alpha Acids*	**14.0 - 17.0 %**
Beta Acids	**5.7 - 8.7 %**
Cohumulone	**51 - 57**
Total Oil	**1.9 - 2.8 ml/100g**
Myrcene	**38 - 45 % of total oil**
Humulene	**9 - 13 % of total oil**
Caryophyllene	**8 - 12 % of total oil**
Farnesene	**< 1 % of total oil**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Vital

Czechia

Multi Purpose Hop

Vital was released from the Czech Žatec Hop Research Institute in 2008 with Agnus as its mother. It was bred primarily for its pharmaceutical and bio-medical attributes, particularly its high xanthohumol content. Vital has high alpha and a spicy, fruity aroma that can be well utilized in brewing. All these attributes earn it a "multi-purpose" designation.

Pedigree	Bred from Czech Agnus
Aroma	Spicy and some fruity
Alpha Acids*	12.0 - 16.0 %
Beta Acids	6.0 - 10.0 %
Cohumulone	21 - 26 % of alpha acids
Total Oil	1.5 - 2.5 ml/100g
Myrcene	40 - 60 % of total oil
Humulene	2 - 5 % of total oil
Caryophyllene	5 - 8 % of total oil
Farnesene	1 - 3 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Wai-Iti

New Zealand Aroma Hop

Wai-Iti is a triploid hop developed through the New Zealand Plant and Food Research Center and released in 2011. It is a granddaughter of USDA Liberty and a Hallertau Mittelfrüh triploid. It exhibits low alpha, moderate essential oils and low cohumulone. Although Wai-Iti's primary aroma is mixed citrus and lime, in beer the hop expresses stone fruit character described as fresh peaches and ripe apricot.

Pedigree	Granddaughter of USDA Liberty
Aroma	Mixed citrus, stone fruits
Alpha Acids*	2.5 - 3.5 %
Beta Acids	4.5 - 5.5 %
Cohumulone	22 - 24 % of alpha acids
Total Oil	1.6 ml/100g
Myrcene	30 % of total oil
Humulene	26 - 30 % of total oil
Caryophyllene	9 - 10 % of total oil
Farnesene	13 % of total oil
Storage Stability	Good

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Waimea

New Zealand Aroma Hop

This high alpha aromatic hop was released through the New Zealand Institute for Plant & Food Research Center in 2012. It is derived from California Late Cluster, Saaz and Fuggle lines and has a distinctive pine needle, and fresh "tangelo" citrus aroma character. Waimea shows a low cohumulone for a high alpha hop and has a relatively high essential oil content.

Pedigree	**Calif. Late Cluster, Saaz, Fuggle**
Aroma	**Pine and citrus**
Alpha Acids*	**16 - 19 %**
Beta Acids	**7 - 9 %**
Cohumulone	**22 - 24 % of alpha acids**
Total Oil	**2.0 - 2.2 ml/100g**
Myrcene	**60 % of total oil**
Humulene	**9 - 10 % of total oil**
Caryophyllene	**2 - 3 % of total oil**
Farnesene	**5 % of total oil**
Storage Stability	**Good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Wakatu

New Zealand
Dual Purpose Hop

Formerly New Zealand Hallertau and renamed Wakatu in 2011, this hop was originally released in 1988 from the New Zealand Hop Research program. It is a triploid derived from Hallertau Mittelfrüh and open pollination. Wakatu a classic style hop with a near 1:1 alpha-beta ratio with a mild floral aroma with some citrus and lime zest character.

Pedigree	**Triploid 2/3 Hallertau – NZ male**
Aroma	**Mild floral, citrus, lime zest**
Alpha Acids*	**6.5 - 8.5 %**
Beta Acids	**8 - 9 %**
Cohumulone	**28 - 30 % of alpha acids**
Total Oil	**1 ml/100g**
Myrcene	**33 - 40 % of total oil**
Humulene	**15 - 19 % of total oil**
Caryophyllene	**7 - 9 % of total oil**
Farnesene	**6 - 8 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Warrior®

U.S.
High Alpha Hop

Warrior® is a high alpha variety developed by Yakima Chief Ranches. It has high agronomic yields and exhibits a moderate tolerance to powdery mildew. Warrior® is characterized by a low cohumulone content and very good storage stability.

Pedigree	**No information**
Aroma	**Very mild**
Alpha Acids*	**14.5 - 16.5 %**
Beta Acids	**4.3 - 5.3 %**
Cohumulone	**22 - 26 % of alpha acids**
Total Oil	**1.3 - 1.7 ml/100g**
Myrcene	**40 - 50 % of total oil**
Humulene	**15 - 19 % of total oil**
Caryophyllene	**9 - 11 % of total oil**
Farnesene	**< 1 % of total oil**
Storage Stability	**Very good**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Whitbread Golding (WGV)

U.K.

Aroma Hop

WGV was selected and developed in 1911 on land owned by Whitbread & Co. Ltd. in the UK. It is not a true Golding, but similarly aromatic. The variety was planted extensively during the 1950s and is known to provide a distinctive sweet fruit flavor in beer, similar to but generally more robust than Goldings.

Pedigree	Grower selection c.1911
Aroma	Earthy, spicy with some fruity
Alpha Acids*	5.0 - 7.5 %
Beta Acids	2.5 - 3.5 %
Cohumulone	35 - 45 % of alpha acids
Total Oil	0.8 - 1.2 ml/100g
Myrcene	24 - 27 % of total oil
Humulene	38 - 42 % of total oil
Caryophyllene	11 - 15 % of total oil
Farnesene	1 - 2 % of total oil
Storage Stability	Fair

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Willamette

U.S.
Aroma Hop

Willamette, the triploid daughter of Fuggle, was released as a U.S. aroma variety in 1976 from the U.S.D.A. breeding program in Oregon. The variety is characterized by a low alpha acids content, mild aroma similar to Fuggle, and average agronomic yields. Until the recent expansion of robust aroma varieties in the U.S., Willamette was a major American aroma variety.

Pedigree	**Triploid seedling of English Fuggle**
Aroma	**Mild and pleasant; slightly spicy**
Alpha Acids*	**4.0 - 6.0 %**
Beta Acids	**3.5 - 4.5 %**
Cohumulone	**30 - 35 % of alpha acids**
Total Oil	**1.0 - 1.5 ml/100g**
Myrcene	**30 - 40 % of total oil**
Humulene	**20 - 27 % of total oil**
Caryophyllene	**7 - 8 % of total oil**
Farnesene	**5 - 6 % of total oil**
Storage Stability	**Fair**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Yakima Gold

U.S.
Aroma Hop

Yakima Gold was developed through the USDA hop breeding program at Washington State University and released in 2013. It is a cross of an Early Cluster and a wild Slovenian male hop with a moderate alpha content and could do well as a dual purpose hop. Its aroma is mild and pleasant with grapefruit, lemon zest, lemongrass and spicy notes.

Pedigree	**Early Cluster and wild Slovenian male**
Aroma	**Mild citrus, lemongrass, spicy**
Alpha Acids*	**8.8 - 10.5 %**
Beta Acids	**4.3 - 5.0 %**
Cohumulone	**21 - 23 % of alpha acids**
Total Oil	**1.9 - 2.3 ml/100g**
Myrcene	**45- 50 % of total oil**
Humulene	**21 - 25 % of total oil**
Caryophyllene	**6 - 8 % of total oil**
Farnesene	**9 - 10 % of total oil**
Storage Stability	**Excellent**

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

Zeus

U.S.
High Alpha Hop

The CTZ super high alpha varieties, which include the names Columbus, Tomahawk and Zeus, have the same female parent as Nugget, making them at least half sisters to Nugget. The CTZ varieties are currently used extensively for beer bittering. CTZ's have very poor storage characteristics and are susceptible to mildews.

Pedigree	Same female parent as Nugget
Aroma	Aromatic, pungent
Alpha Acids*	15.0 - 17.0 %
Beta Acids	4.5 - 5.0 %
Cohumulone	28 - 32 % of alpha acids
Total Oil	2.5 - 3.5 ml/100g
Myrcene	50 - 60 % of total oil
Humulene	12 - 18 % of total oil
Caryophyllene	9 - 11 % of total oil
Farnesene	< 1 % of total oil
Storage Stability	Very poor

* Alpha acids are determined by conductometric titration (EBC 7.4) in Europe; by spectrophotometric (ASBC Hops-6) in USA

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