Lúpulo y Lupuladas
(clase 2)

Lic. Sebastián Oddone
Especialista en Fermentaciones Industriales

Hoy vamos a hablar de «aroma»

- **La química del aroma es mucho más compleja que la del amargor**
- **La cromatografía gaseosa (1950) permitió descubrir los cientos de componentes del lúpulo que impactan en aroma**
- **No existe una simple fórmula que correlacione la composición en aceites y el flavor desarrollado**
- **El aroma a «lúpulo», hoppy aroma es una combinación sinérgica**

Ocurres cosas tan complejas como esto:

Un estudio alemán reportó que una mezcla de cariofileno y nerol (2 componentes del aceite de los lúpulos) tendría un umbral de flavor de unos 170 ppb.

Comparado con los umbrales individuales de 210 y 1200 ppb respectivamente. Lo mismo ocurre con otras combinaciones.

Los porcentajes de cada componente en las mezclas también cambian los umbrales de percepción

Aceites

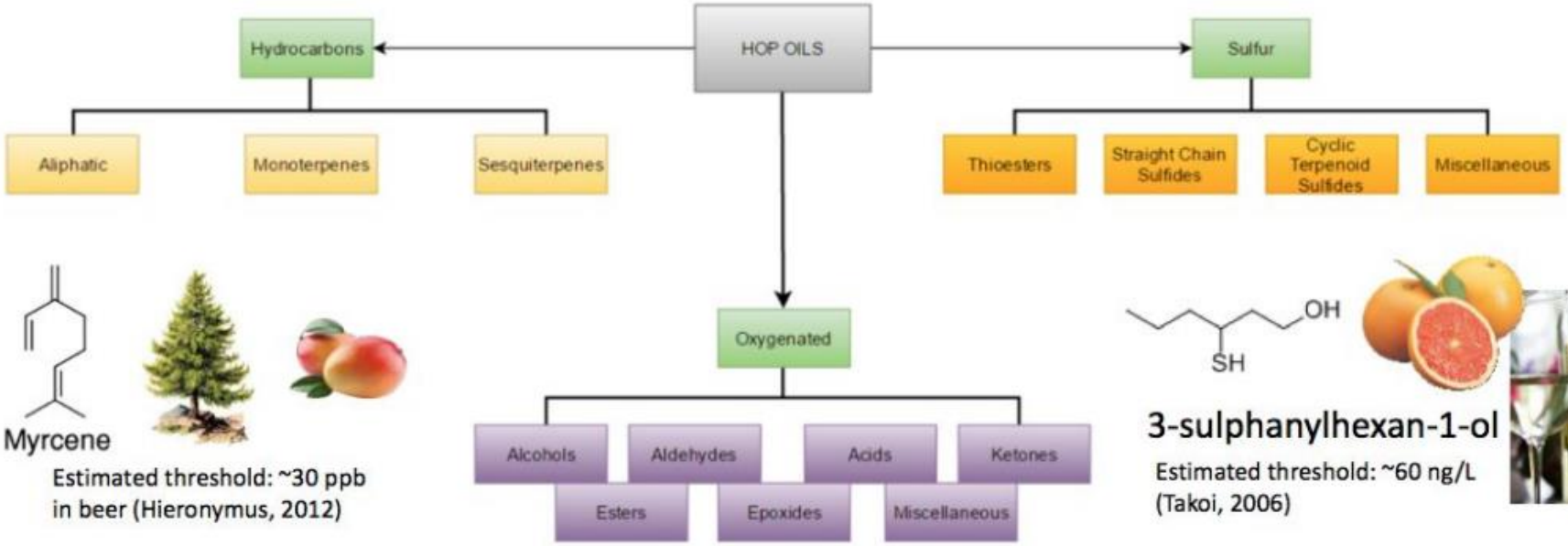
Hopsteiner

Principal Constituents of *Hop Oils*

ESSENTIAL OILS

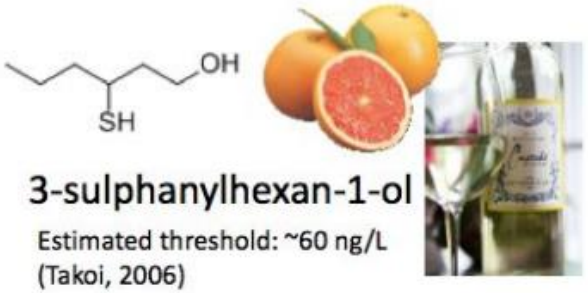
HYDROCARBON FRACTION	OXYGENATED FRACTION	SULPHUR FRACTION
50-80%	20-50%	<1.0%
• Highly volatile • Not very soluble •Apparent when dry hopping	• Volatile • More soluble •***Desirable hop characters***	• Highly volatile •Undesirable •Sulphury, dirty aromas
60+ compounds	*230+ compounds*	*30+ compounds*

Aceites



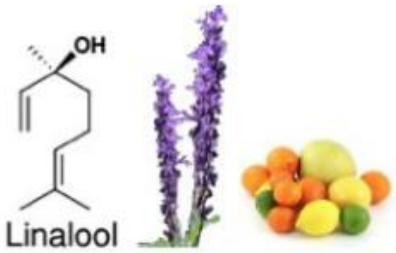
Myrcene

Estimated threshold: ~30 ppb in beer (Hieronymus, 2012)



3-sulphanylhexan-1-ol

Estimated threshold: ~60 ng/L (Takoi, 2006)

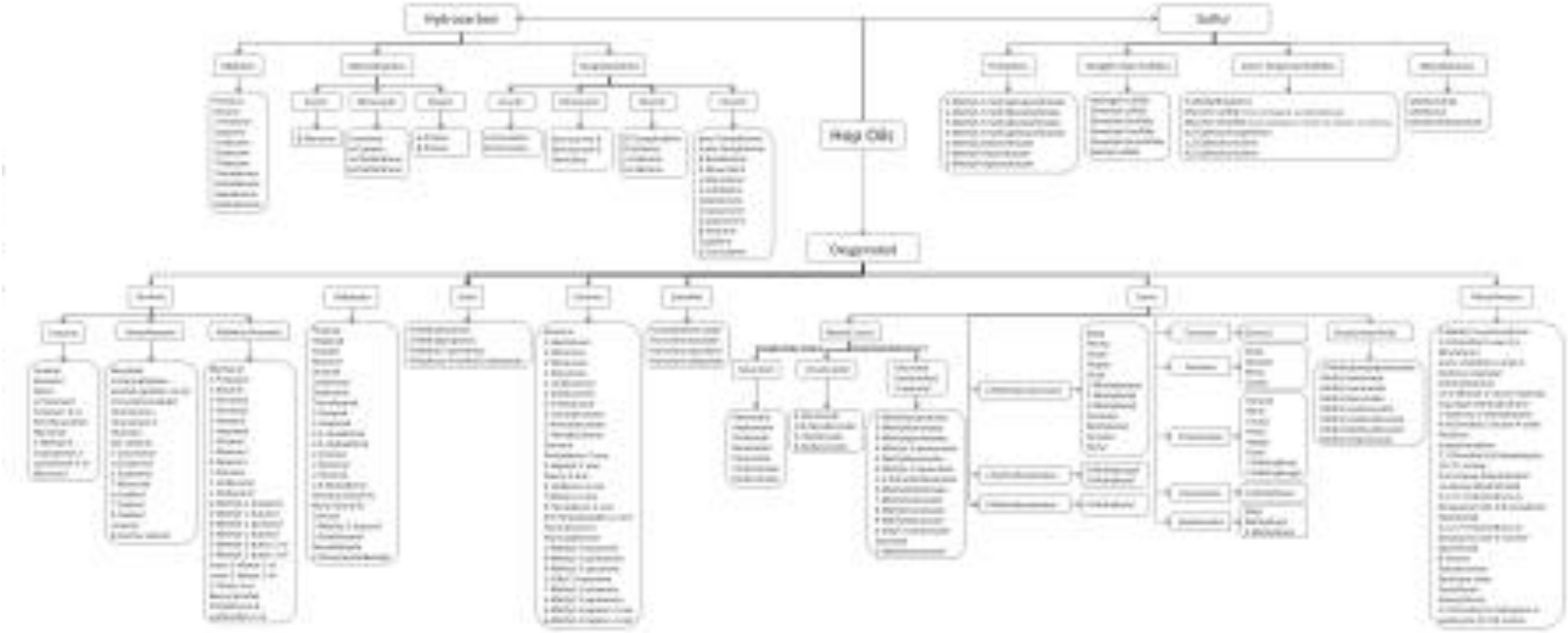


Linalool

Estimated threshold: ~10 ppb in beer (Almaguer, 2014)

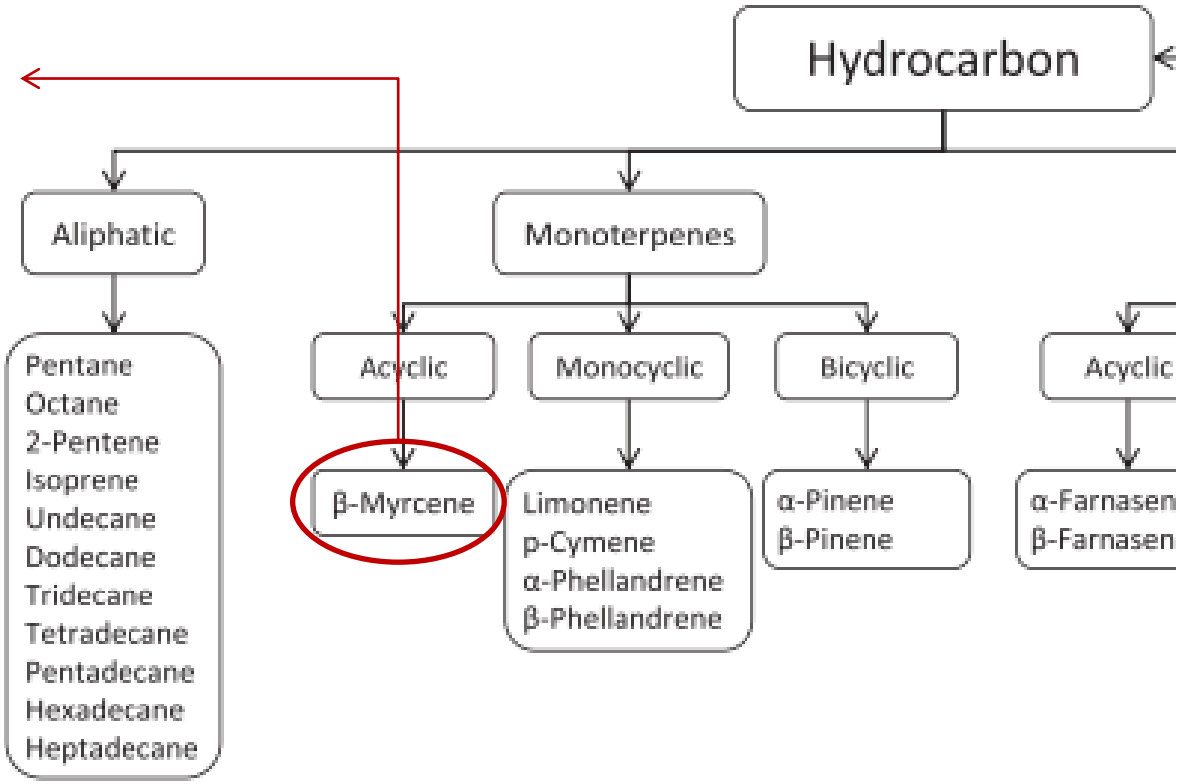
Aceites


Los alfa y beta ácidos del lúpulo
glándulas de lupulina
resinas
polifenoles
aceites esenciales
duras
blandas
hidrocarbonados
azufrados
oxigenados
fracción y
alfa ácidos
beta ácidos
aroma
amargor
BENAPRA



Aceites

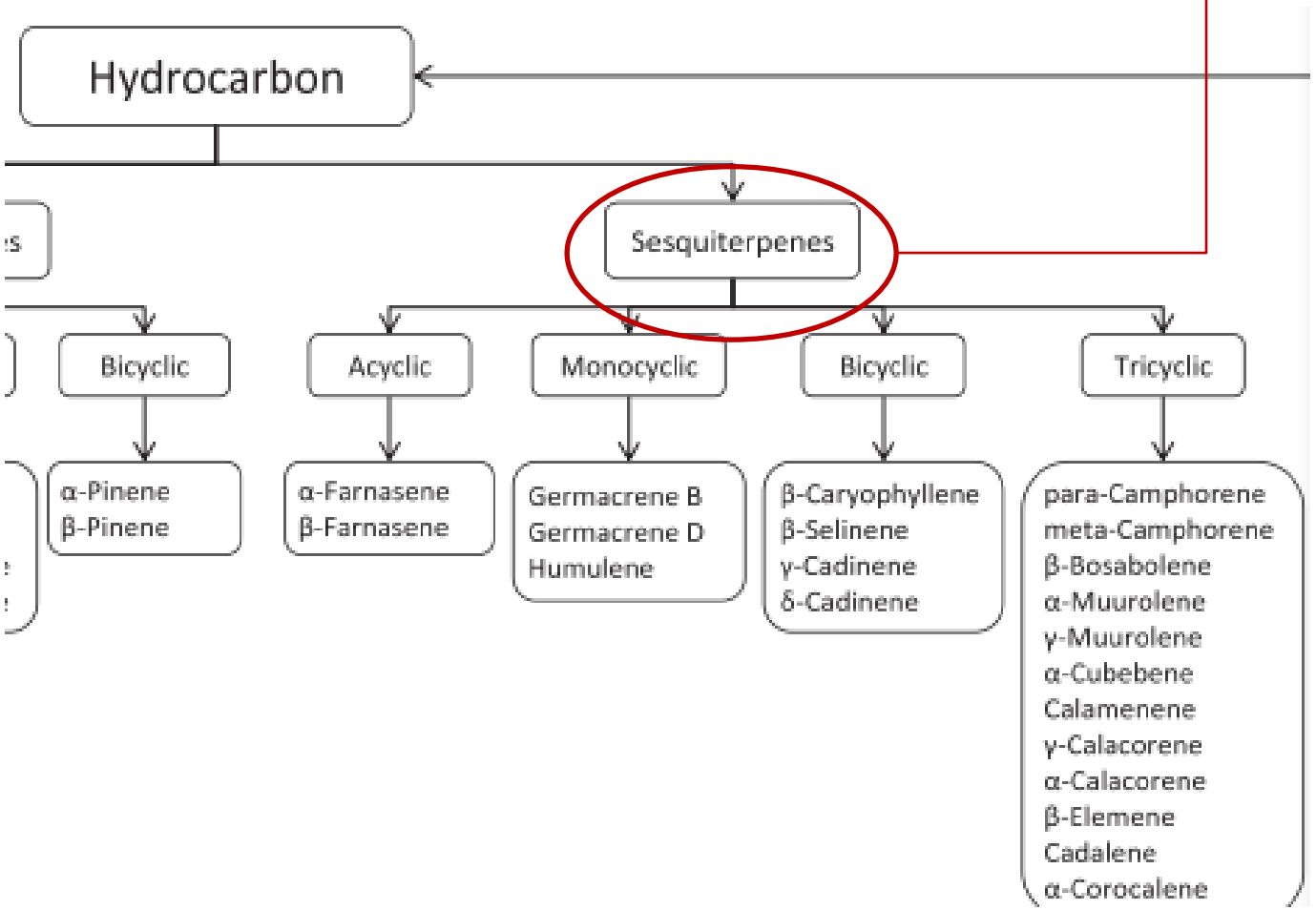
Aroma a lúpulo fresco



Hidrocarbonados: fracción muy volátil y muy poco soluble. Se oxidan y polimerizan fácilmente.

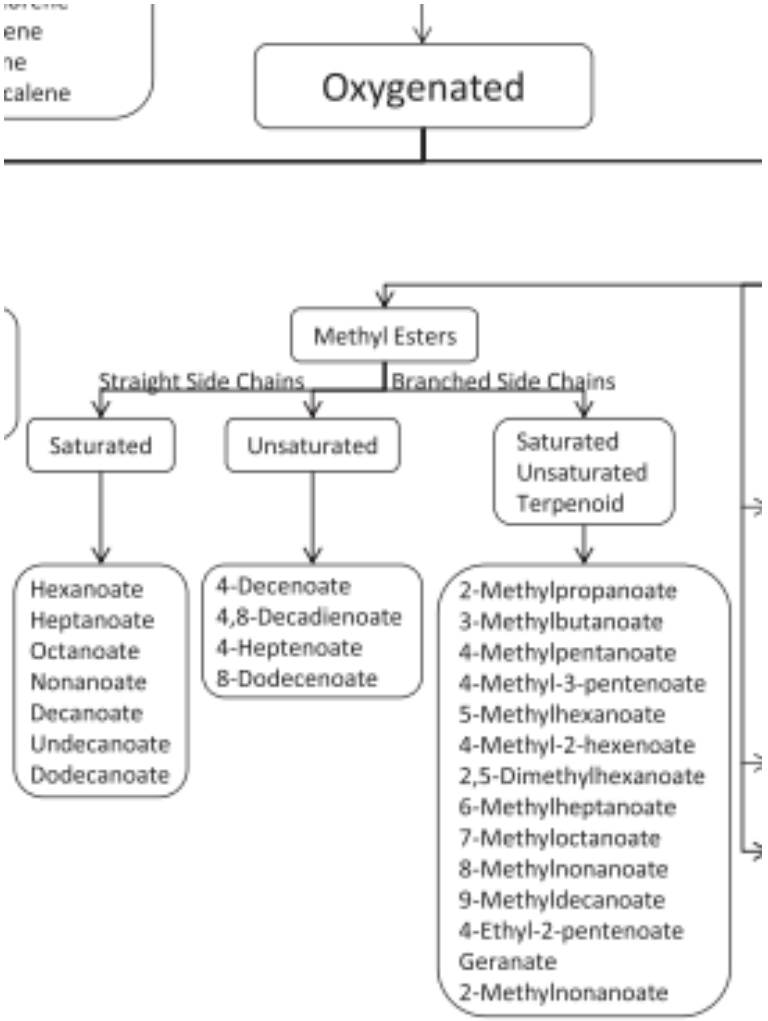
Aceites

Especiadas



Aceites

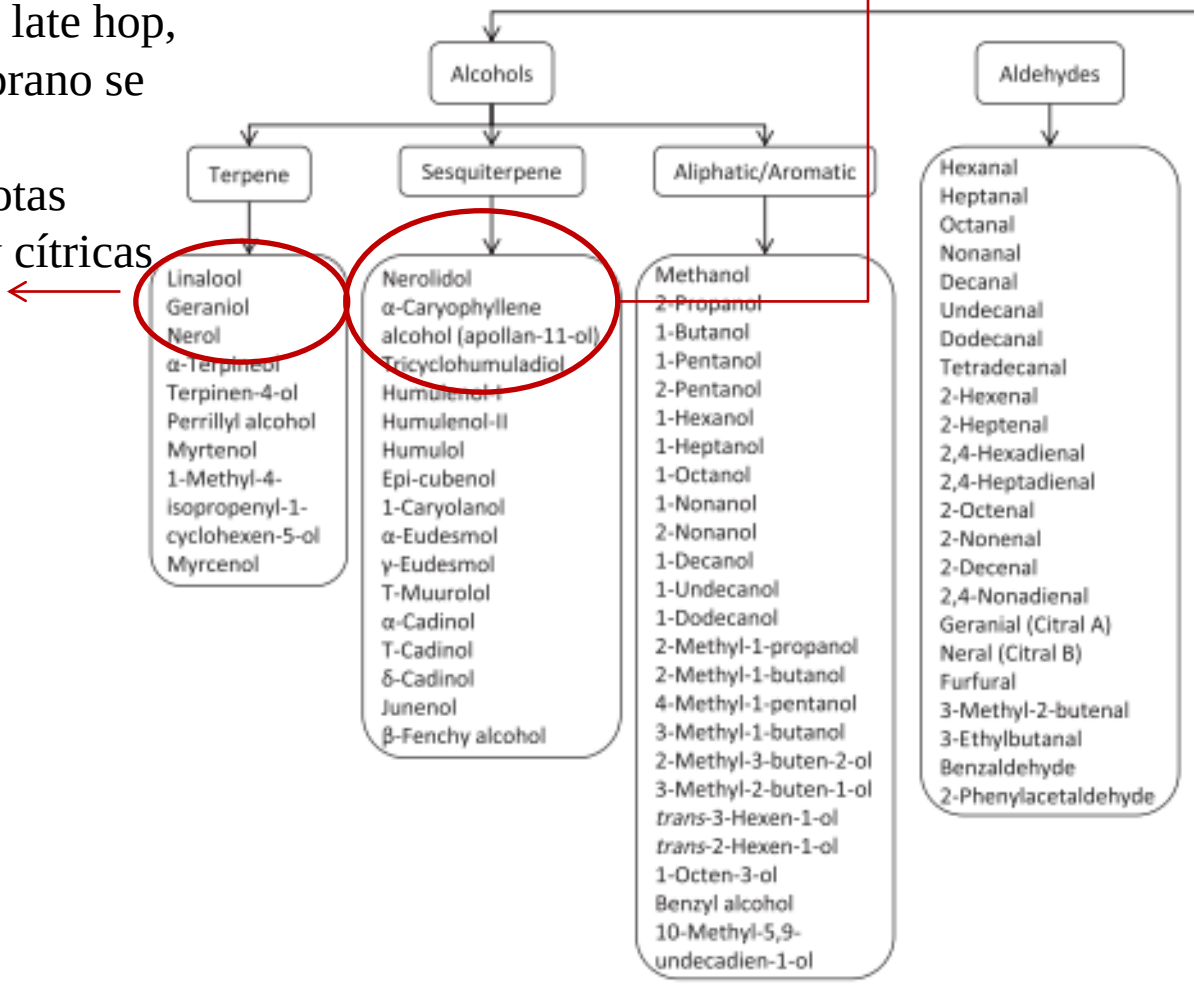
Oxigenados: contiene compuestos volátiles y otros menos volátiles. Con el tiempo algunos hidrocarbonados y algunos compuestos volátiles oxigenados se van transformando en oxigenados no volátiles.



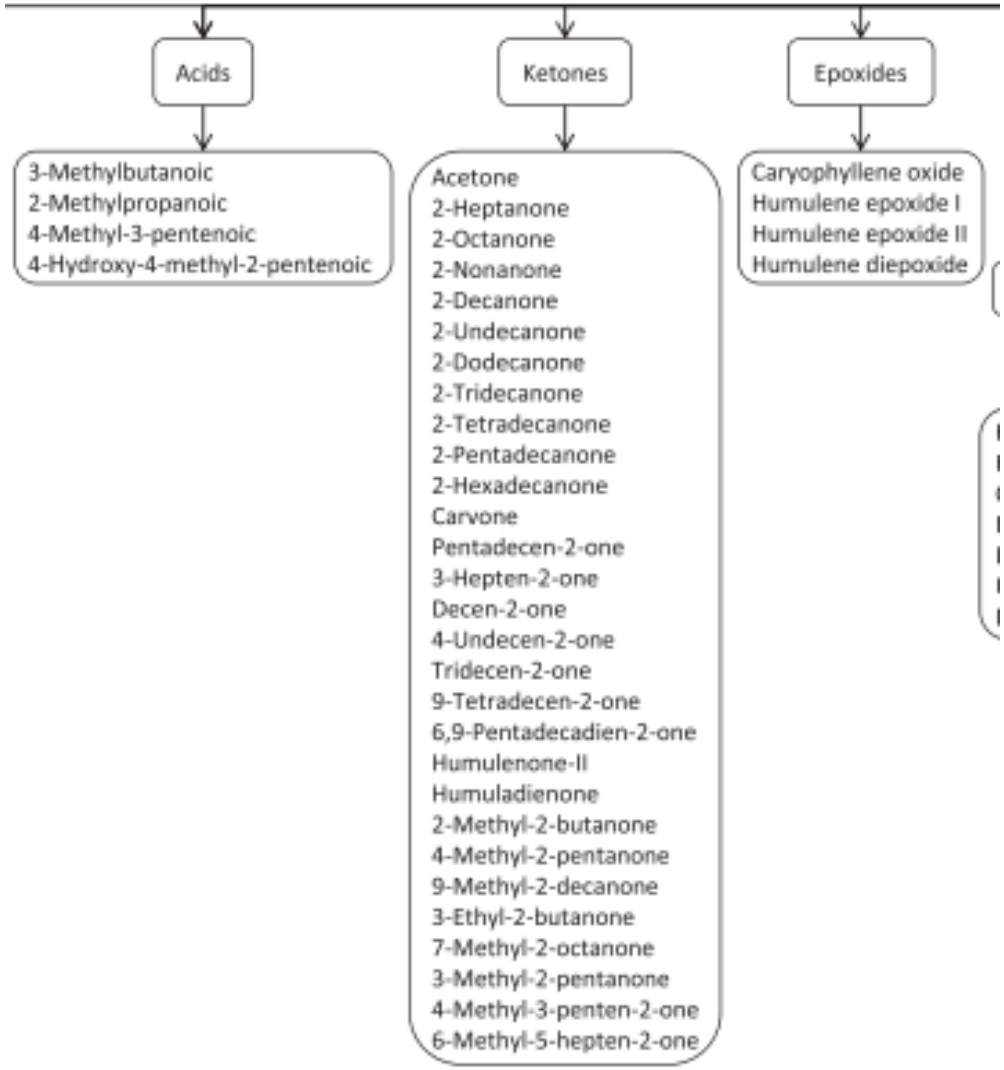
Aceites

Carácter especiado y herbal

Puede brindar aroma en late hop, más temprano se pierde.
Brinda notas florales y cítricas

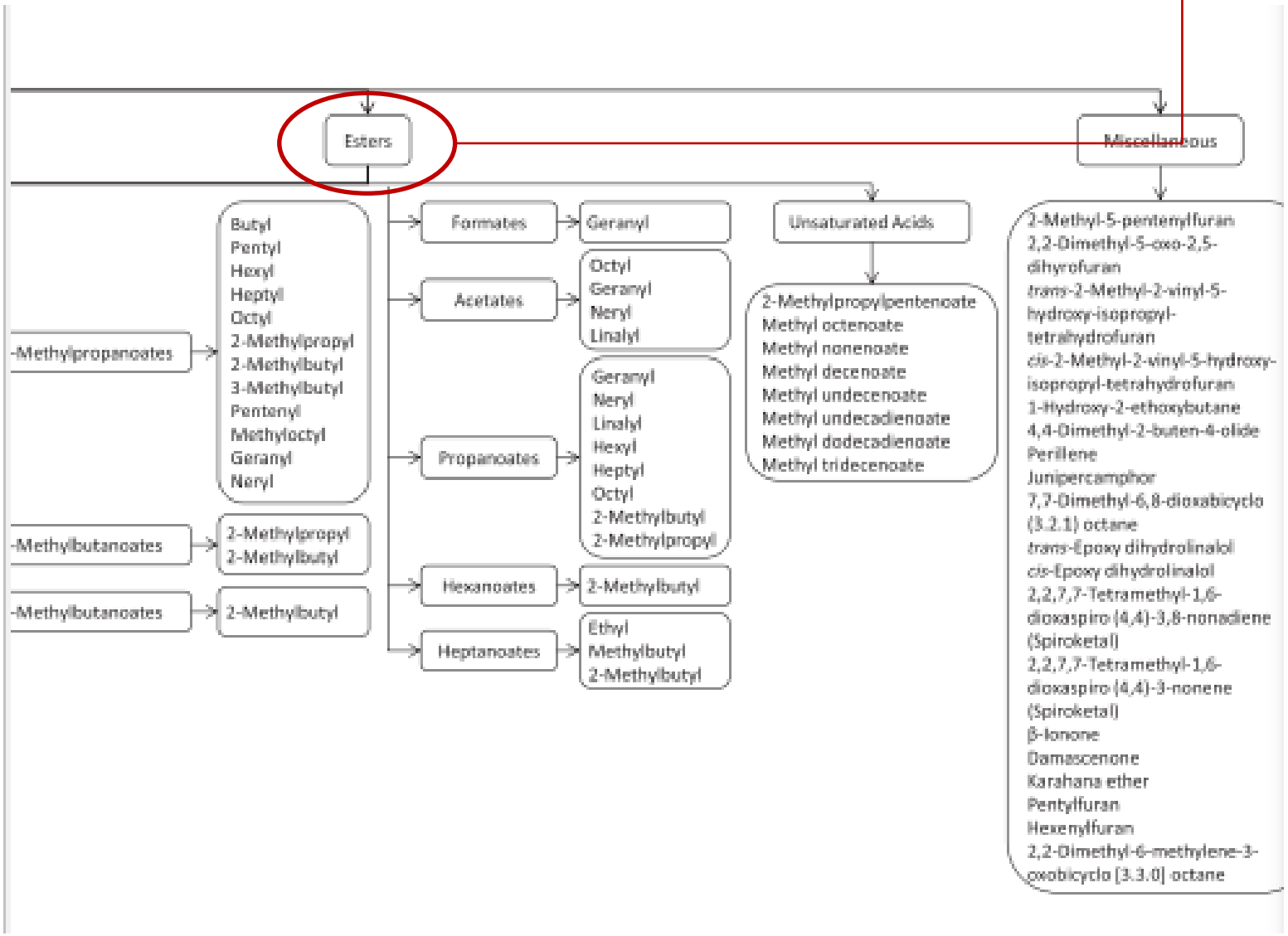


Aceites


Acids
3-Methylbutanoic
2-Methylpropanoic
4-Methyl-3-pentenoic
4-Hydroxy-4-methyl-2-pentenoic
Ketones
Acetone
2-Heptanone
2-Octanone
2-Nonanone
2-Decanone
2-Undecanone
2-Dodecanone
2-Tridecanone
2-Tetradecanone
2-Pentadecanone
2-Hexadecanone
Carvone
Pentadecen-2-one
3-Hepten-2-one
Decen-2-one
4-Undecen-2-one
Tridecen-2-one
9-Tetradecen-2-one
6,9-Pentadecadien-2-one
Humulenone-II
Humuladienone
2-Methyl-2-butanone
4-Methyl-2-pentanone
9-Methyl-2-decanone
3-Ethyl-2-butanone
7-Methyl-2-octanone
3-Methyl-2-pentanone
4-Methyl-3-penten-2-one
6-Methyl-5-hepten-2-one
Epoxides
Caryophyllene oxide
Humulene epoxide I
Humulene epoxide II
Humulene diepoxide

Frutales y florales

Aceites

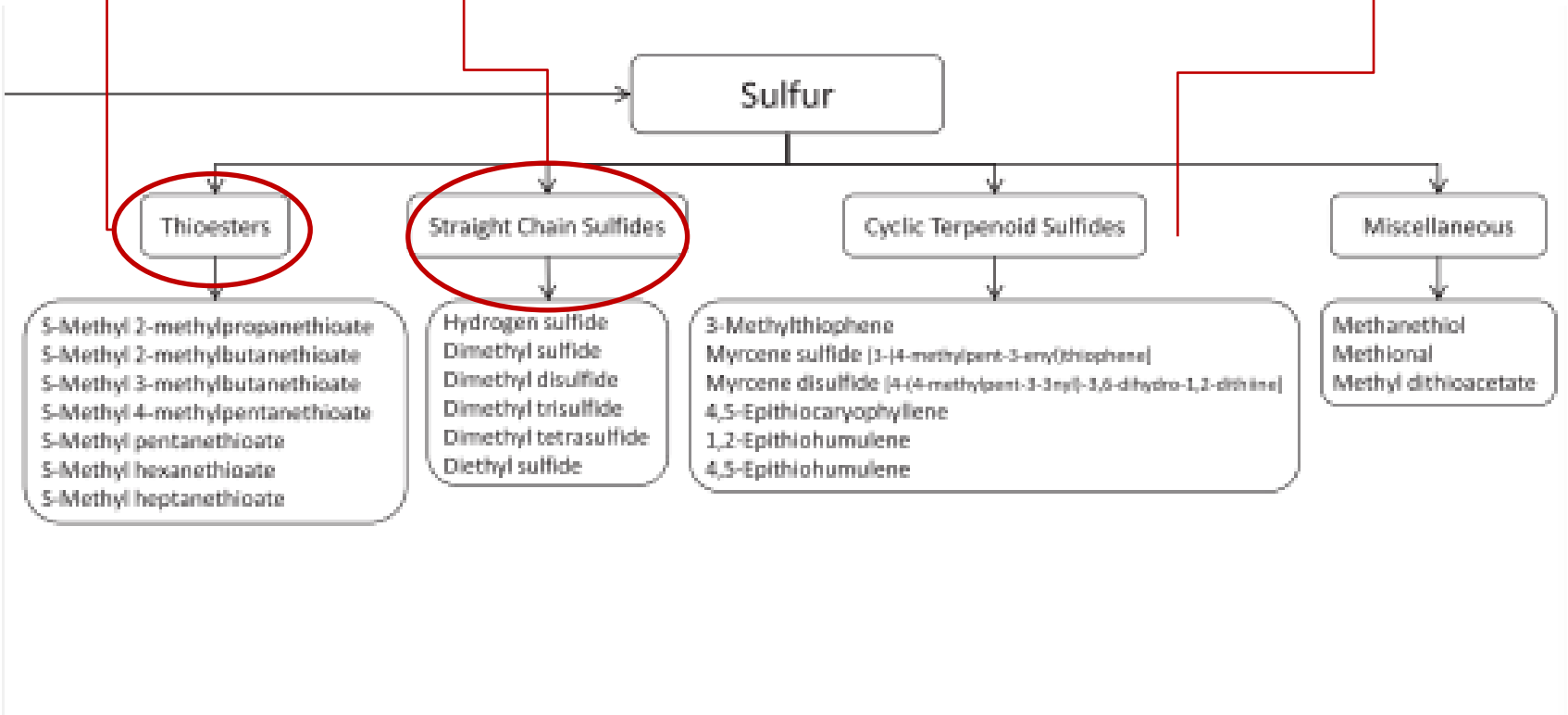


Aceites

Ajo, cebolla

Vegetales
cocidos, queso

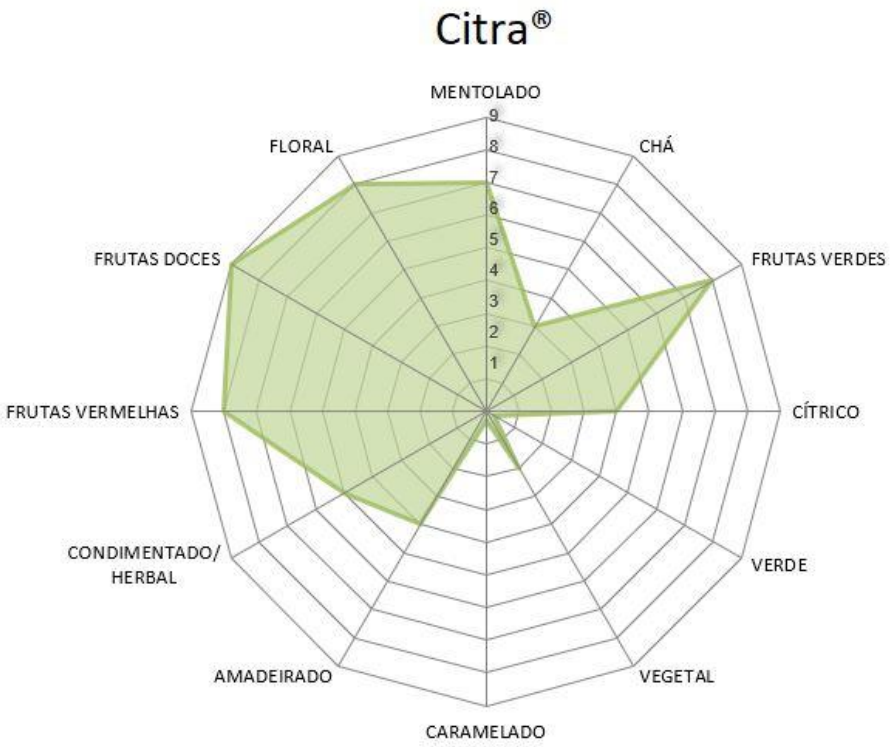
Frutas exóticas,
uva, maracuyá



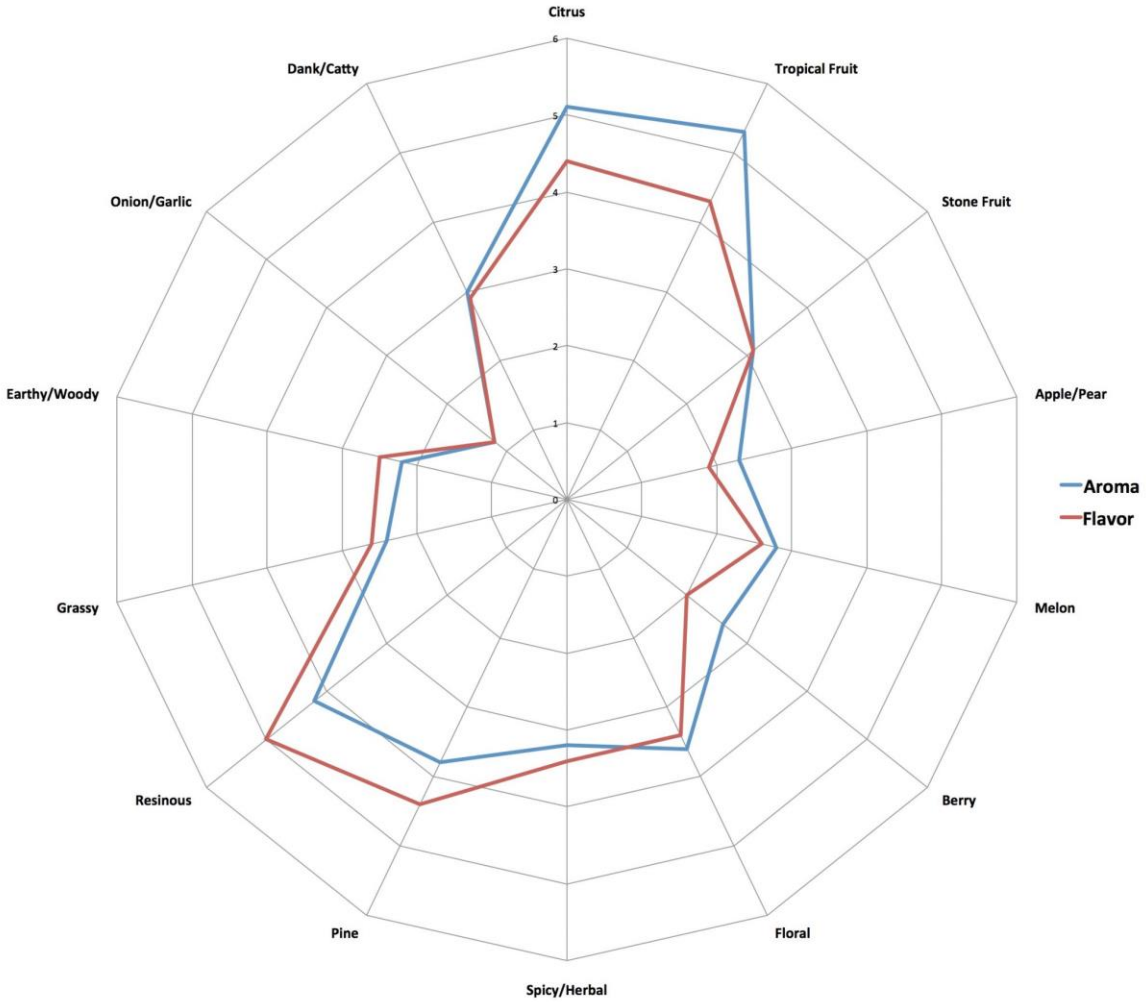
Aceites

Hop Variety	Myrcene - green, resinous	B-Pinene - spicy, piney	Humulene - piney, woody	Caryophyllene - woody	Farnesene - floral	Geraniol - floral, sweet, rose	Linalool - floral, orange	Other Oils
AHTANUM™	54.11%	0.91%	20.69%	10.06%	0.12%	0.27%	0.36%	13.51%
AMARILLO®	52.14%	0.79%	17.90%	6.53%	6.39%	0.16%	0.61%	15.48%
BITTER GOLD	53.02%	0.82%	13.49%	8.62%	0.19%	0.15%	0.54%	23.17%
Bravo	62.37%	1.02%	8.97%	6.62%	0.19%	0.50%	0.47%	19.85%
Brewers Delight	45.90%	0.76%	15.22%	8.80%	0.62%	0.28%	0.45%	27.99%
Brewers Gold	56.44%	0.84%	15.65%	9.61%	0.23%	1.34%	0.68%	15.21%
BULLION	49.11%	0.76%	18.84%	10.95%	0.43%	0.21%	0.74%	18.98%
CASCADE	56.33%	0.83%	14.19%	6.23%	6.30%	0.18%	0.49%	15.44%
Centennial	65.37%	1.09%	10.68%	5.23%	0.20%	1.14%	0.67%	15.63%
CHELAN	50.35%	0.70%	12.66%	10.09%	0.18%	0.27%	0.39%	25.36%
CHINOOK	38.21%	0.60%	18.35%	8.50%	0.30%	0.59%	0.45%	33.00%
CITRA®	66.53%	0.88%	8.73%	5.58%	0.15%	0.30%	0.77%	17.07%
Cluster	43.69%	0.67%	18.82%	8.45%	0.31%	0.83%	0.46%	26.78%
Columbus	53.20%	0.89%	11.99%	7.58%	0.23%	0.26%	0.45%	25.39%
CRYSTAL	44.67%	0.67%	26.58%	7.34%	0.12%	0.59%	0.90%	19.14%
EQUINOX™	34.09%	0.50%	19.07%	10.90%	0.29%	0.33%	0.56%	34.26%
Fuggle	24.24%	0.35%	36.37%	14.01%	6.54%	0.11%	0.78%	17.60%
Galena	47.45%	0.71%	13.53%	7.44%	0.22%	0.41%	0.42%	29.82%
Glacier	43.95%	0.58%	29.08%	9.11%	0.21%	0.23%	0.79%	16.06%
Golding	25.89%	0.36%	39.84%	12.37%	0.71%	0.09%	0.79%	19.95%
GR Brewers Gold	26.55%	0.50%	30.48%	14.61%	0.20%	1.16%	0.52%	25.98%
GR HALLERTAU	24.93%	0.34%	36.18%	10.37%	2.08%	0.26%	0.79%	25.05%
GR Herkules	44.25%	0.64%	25.62%	7.14%	0.19%	0.16%	0.27%	21.73%
GR Northern Brewer	35.47%	0.58%	32.41%	12.34%	0.10%	0.18%	0.49%	18.42%
GR PERLE	25.91%	0.40%	40.38%	14.67%	6.62%	0.06%	0.32%	11.63%
GR Tettnang	11.80%	0.22%	27.12%	7.74%	23.70%	0.14%	0.52%	28.76%
Hallertau	30.90%	0.41%	32.39%	9.64%	5.70%	0.23%	0.77%	19.97%
HORIZON	49.79%	0.70%	16.36%	11.13%	3.51%	0.22%	1.10%	17.21%
Liberty	29.94%	0.41%	37.86%	9.58%	0.55%	0.10%	1.06%	20.50%
Magnum	41.24%	0.63%	31.21%	9.98%	0.47%	0.14%	0.39%	15.94%
MILLENNIUM	44.55%	0.65%	22.20%	9.26%	0.21%	0.13%	0.55%	22.46%
MOSAIC™	61.84%	0.89%	10.62%	4.24%	0.12%	0.59%	0.69%	21.00%
MT. HOOD	41.97%	0.65%	26.80%	12.49%	0.20%	0.26%	0.83%	16.81%
Mt. Rainier	58.04%	0.78%	17.92%	7.66%	0.10%	0.29%	0.82%	14.42%
Newport	52.21%	0.79%	17.32%	9.24%	0.41%	0.20%	0.49%	19.37%
Northern Brewer	39.86%	0.66%	29.44%	13.24%	0.61%	0.15%	0.48%	15.56%
Nugget	51.15%	0.67%	18.80%	9.07%	0.26%	0.07%	1.02%	18.97%
PALISADE®	52.51%	0.83%	14.89%	11.92%	0.20%	0.25%	0.43%	18.97%
PERLE	33.04%	0.50%	35.28%	14.03%	1.03%	0.22%	0.41%	15.48%
Saaz	32.28%	0.49%	28.18%	10.78%	10.84%	0.22%	0.71%	16.49%
Santiam	24.59%	0.34%	25.81%	7.88%	17.04%	0.09%	0.87%	23.43%
SIMCOE®	50.35%	0.78%	17.42%	8.72%	0.20%	0.66%	0.61%	21.25%
SORACHI ACE	50.49%	0.75%	22.62%	7.63%	5.03%	0.31%	0.51%	12.67%
ST AURORA	36.68%	0.53%	24.16%	7.27%	6.53%	0.85%	1.00%	22.99%
ST Celeia	17.60%	0.27%	32.13%	12.82%	7.15%	0.11%	0.79%	29.14%
STERLING	40.13%	0.52%	18.33%	6.66%	13.64%	0.21%	0.66%	14.80%

Los perfiles de los lúpulos



Los perfiles de los lúpulos



Ejemplo: MOSAIC

http://brulosophy.com/2017/02/16/the-hop-chronicles-mosaic/

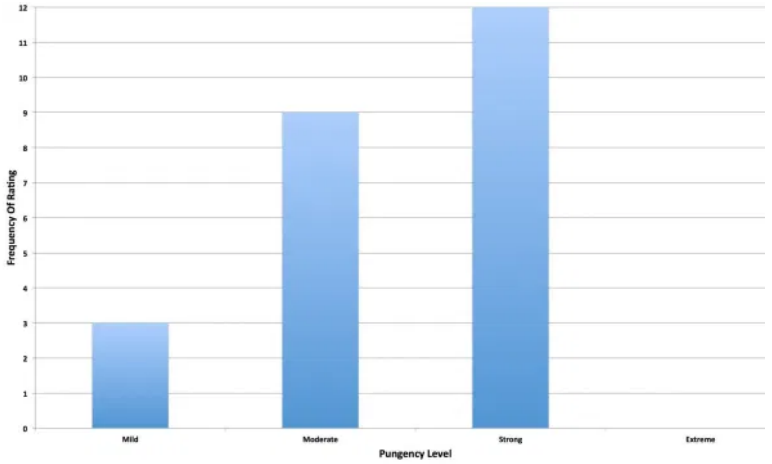
The 3 characteristics endorsed as being *most prominent* by participants:

Aroma	Flavor
Tropical Fruit	Resinous
Citrus	Citrus & Pine (tie)
Resinous	Tropical Fruit

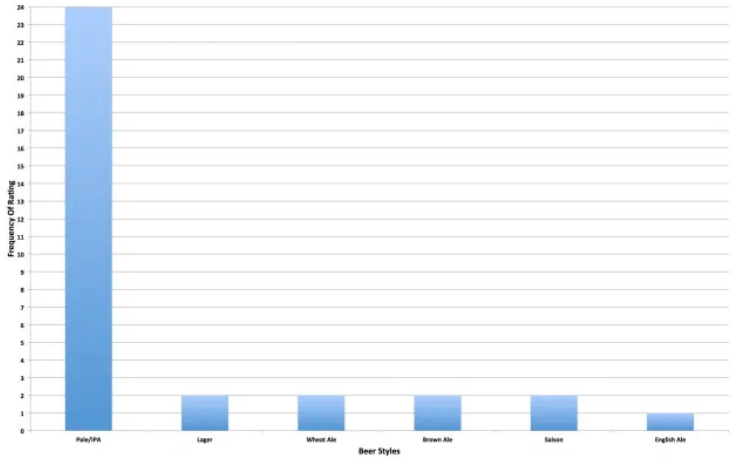
The 3 characteristics endorsed as being *least prominent* by participants:

Aroma	Flavor
Onion/Garlic	Onion/Garlic
Earthy/Woody	Apple/Pear
Apple/Pear	Berry

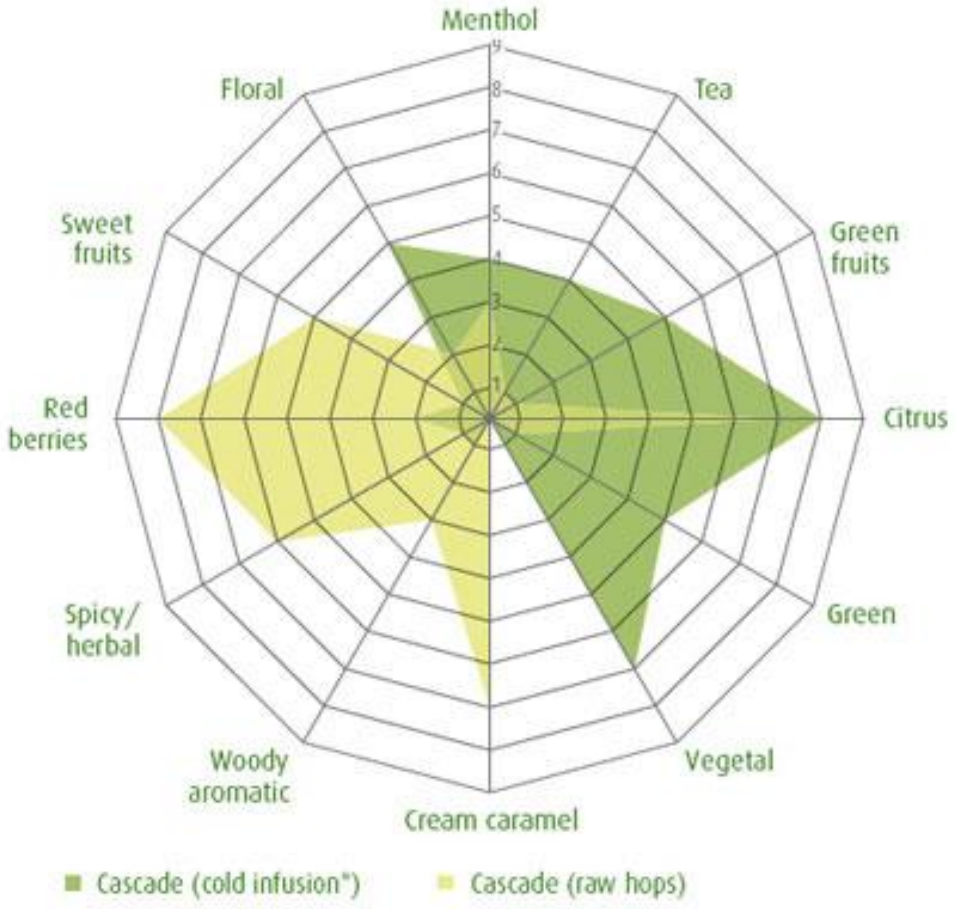
Participants were asked to the pungency of the hop the hop character.



They were then instructed to identify beer styles they thought the hop would work well in.



Lúpulo vs Cerveza

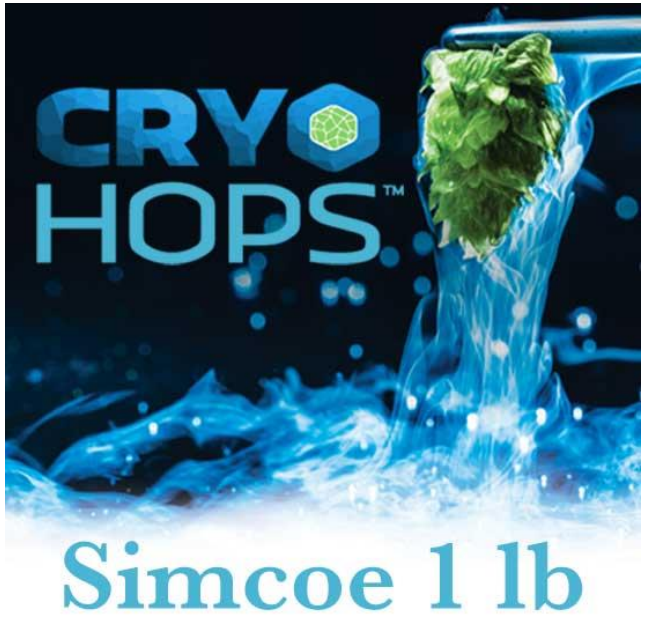


Cryo Hops

Cryo hops es un producto de Yakima Hopunion. Diseñados para elaborar cervezas extremadamente aromáticas y con baja o nula astringencia

Se trata de lupulina concentrada, sin material vegetal.

Se utilizan en dosis a la mitad que los pellets, y en general se incorporan tanto pellets como cryos en mezclas en proporciones 30 a 50% del cryo.



Cryo Hops

LUPOMAX™ Concentrated Hop Pellets

LUPOMAX™ is a new concentrated pellet that is consistent, efficient, and optimized for hop flavor. LUPOMAX™ has less vegetative matter compared to regular hop pellets so you get hop flavors that are bigger, bolder, and brighter! Less vegetative matter means less beer loss, less solid waste, and more beer to enjoy. LUPOMAX™ is variety and crop year specific and made with premium lots that are selected to deliver consistent true-to-type flavor year over year.

LUPOMAX™ = Consistent lupulin concentration for optimized hop flavor.

- Consistent lupulin concentration for optimized hop flavor
- Sensory Plus™: process delivers consistency and true-to-type hop flavor
- Lupulin standardization for reliable brewing performance
- Reduces beer loss; more beer to sell

When replacing T90 pellets with LUPOMAX™, use 70% of the hops called for in your recipe.

Productos alternativos

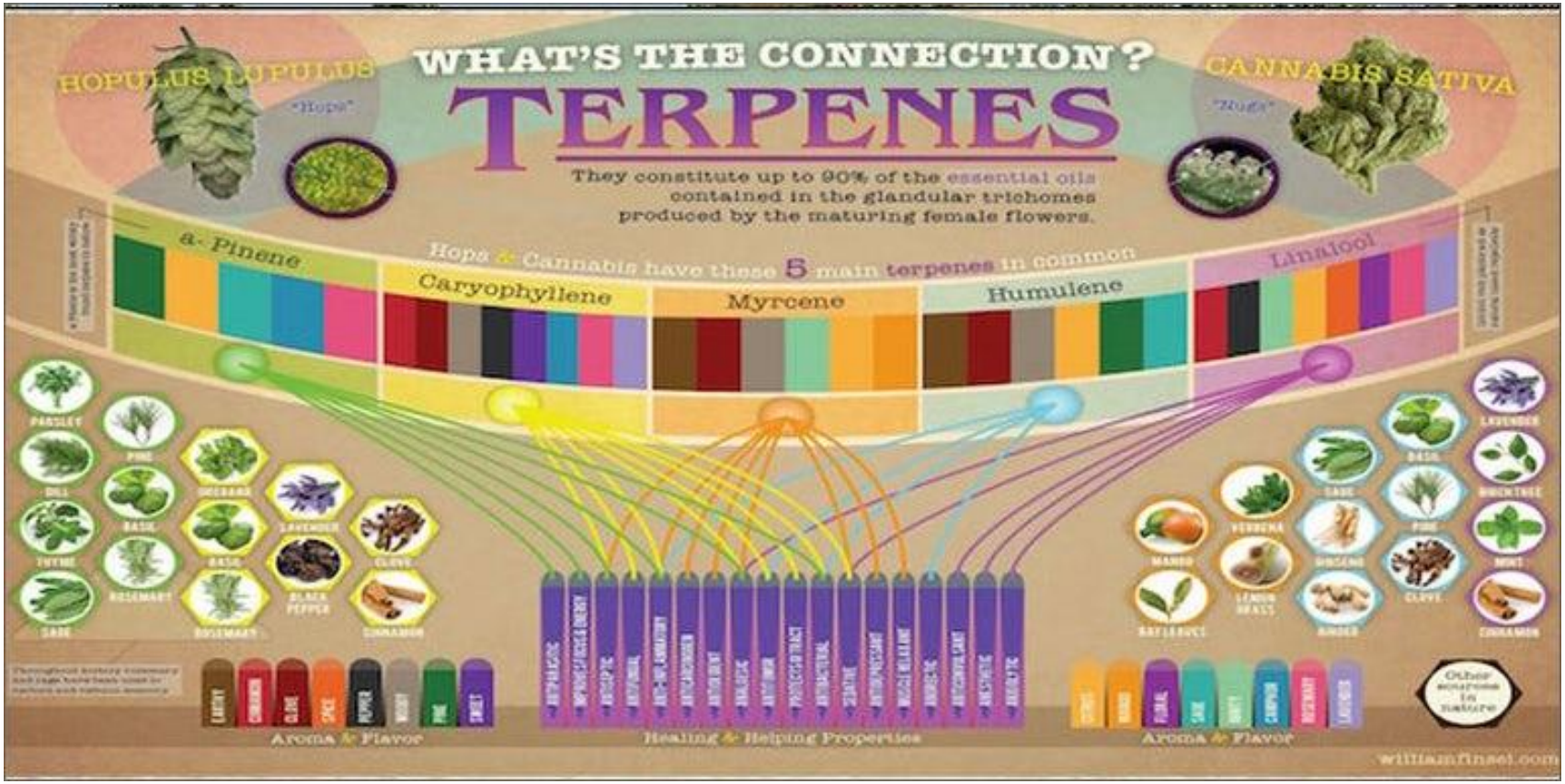
CURRENT AVAILABILITY	CRYO HOPS® PELLETS		TYPICAL ANALYSIS ALPHA BY UV SPECTROSCOPY & OIL BY DISTILLATION	
	1X5KG/11 LB	4X5KG/11 LB	ALPHA*	OIL* (mL/100g)
AMARILLO® BRAND VGXP01	◉	◉	13 - 20%	1.8 - 4.1
CASCADE	◉	◉	12 - 19%	1.9 - 3.7
CENTENNIAL	◉	◉	13 - 22%	1.8 - 5.4
CITRA® BRAND HBC 394 CV	◉	◉	19 - 30%	2.4 - 6.6
EKUANOT® BRAND HBC 366 CV	◉	◉	21 - 26%	3.8 - 6.0
LORAL® BRAND HBC 291 CV	◉	◉	18 - 23%	3.0 - 4.9
MOSAIC® BRAND HBC 369 CV	◉	◉	21 - 26%	2.3 - 4.3
PALISADE® BRAND YCR 4 CV	◉	◉	12 - 18%	1.4 - 3.6
SIMCOE® BRAND YCR 14 CV	◉	◉	21.5 - 27%	2.6 - 4.5

** Actual alpha and oil percentages will vary based on lot and crop year.*

CURRENT AVAILABILITY	AMERICAN NOBLE HOPS™ PELLETS		TYPICAL ANALYSIS ALPHA BY UV SPECTROSCOPY & OIL BY DISTILLATION	
	1X5KG/11 LB	4X5KG/11 LB	ALPHA*	OIL* (mL/g)
AMARILLO® BRAND VGXP01	◉	◉	1.5%	> 1
CASCADE	◉	◉	0.8%	> 1
CITRA® BRAND HBC 394 CV	◉	◉	2.6%	> 1
LORAL® BRAND HBC 291 CV	◉	◉	3.0%	> 1
MOSAIC® BRAND HBC 369 CV	◉	◉	2.2%	> 1
PALISADE® BRAND YCR 4 CV	◉	◉	1.5%	> 1
SIMCOE® BRAND YCR 14 CV	◉	◉	2.2%	> 1

** Actual alpha and oil percentages will vary based on lot and crop year.*

Terpenos

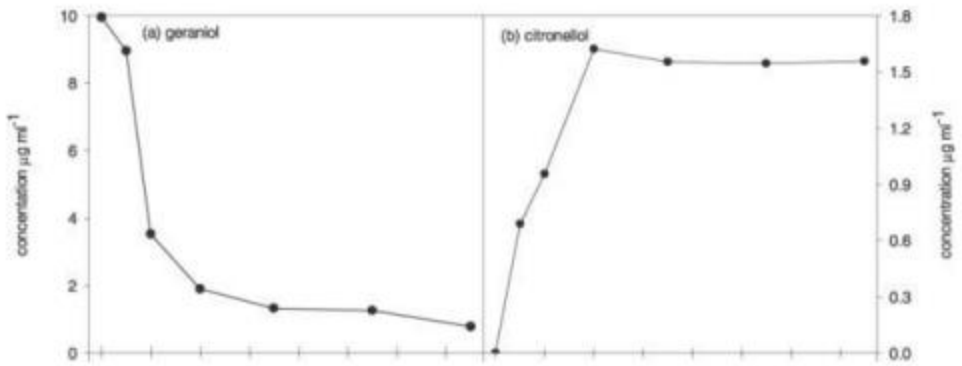

HOPULUS LUPULUS
"Hops"
WHAT'S THE CONNECTION?
TERPENES
They constitute up to 90% of the essential oils contained in the glandular trichomes produced by the maturing female flowers.
CANNABIS SATIVA
"Hops"
Hops & Cannabis have these 5 main terpenes in common
a- Pinene
Caryophyllene
Myrcene
Humulene
Linalool
Aroma & Flavor
Healing & Helping Properties
Aroma & Flavor
Other aromas in nature
williamfinnel.com

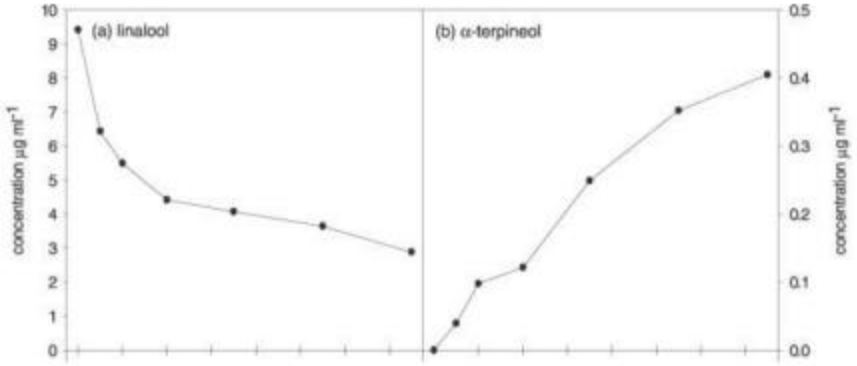
Terpenos

Extraídos con CO2 supercrítico

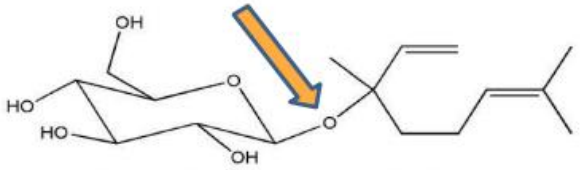
Los Glicósidos del Lúpulo

“Biotransformación”

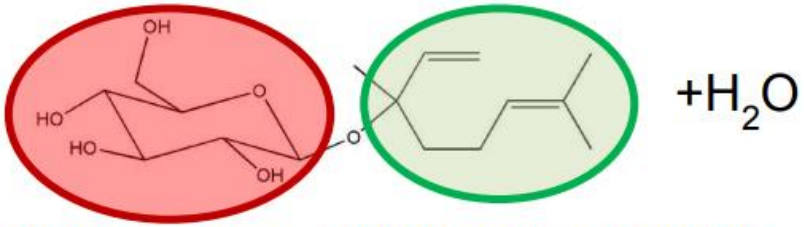




ENZYME (β-glycosidase)



LINALYL GLYCOSIDE (**Non-aromatic**)



$+H_2O$

CARBOHYDRATE (Glucose) **HOP OIL** (Linalool) **AROMATIC**

El O_2: el peor enemigo

Una cerveza (especialmente lupulada) podría oxidarse en distintos momentos e instancias del proceso de elaboración:

Consumo de antioxidantes por oxidación del lado caliente

Durante la fermentación primaria si utilizara un fermentador con una tapa medio floja, o bien por ingreso de oxígeno al momento de alguna adición.

Cuánto menor es el volumen del fermentador, mayor el riesgo de oxidación (mayor área de contacto)

Oxidación de los aceites

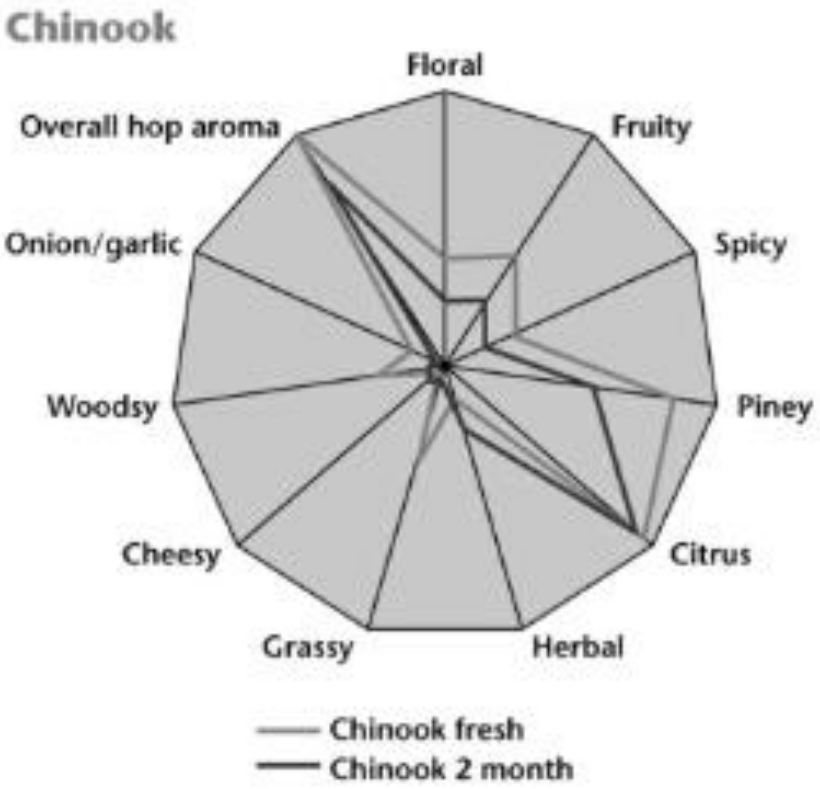
En general disminuyen los contenidos de aceites, particularmente mirceno.

Los sesquiterpernos podrían generar productos de oxidación durante el hervor que favorecerían los flavor conocidos como «kettle aroma», típicos de algunas cervezas alemanas. Se trata del aroma especiado, herbal y terroso.

La oxidación de algunos aceites de sulfuro durante el whirlpool podría causar aromas a ajo y cebolla en la cerveza.

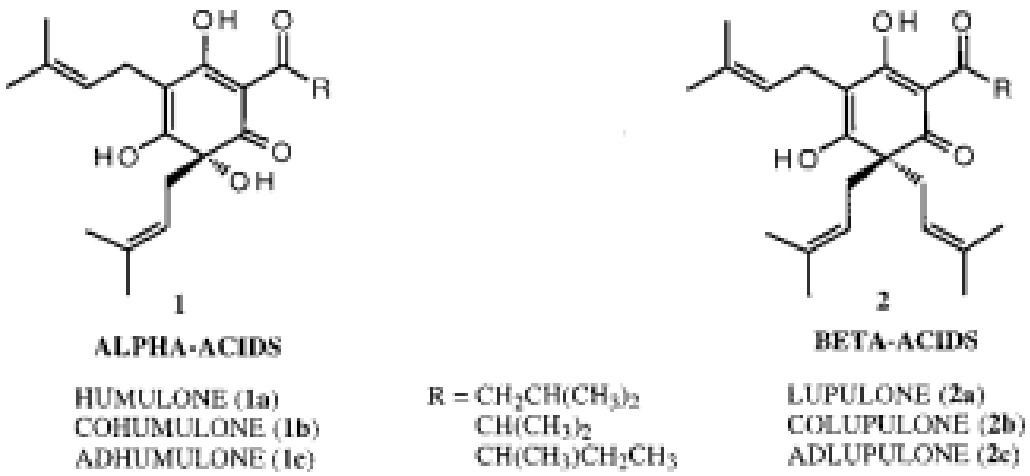
La oxidación de otros aceites podría generar aromas de cartón húmedo, o aromas tipo caramelo o toffee.

Oxidación de los aceites



Ahora vamos a hablar de «amargor»

- **Principalmente determinado por las resinas alfa (humulonas) y beta-ácidos (lupulonas)**



- **Sin embargo, veremos que hay otros compuestos con efecto sobre el amargor**

Productos alternativos

CURRENT AVAILABILITY	CO_2 HOP EXTRACT		TYPICAL ANALYSIS ALPHA BY UV SPECTROSCOPY & OIL BY DISTILLATION		
	24 X 150 GMA	12 X 300 GMA	ALPHA*	BETA*	OIL* (mL/g)
AMARILLO® BRAND VGXP01	◉	◉	38 - 45%	25 - 33%	5 - 8
CASCADE	◉	◉	35 - 42%	35 - 40%	4 - 7
CHINOOK	◉	◉	55 - 62%	15 - 20%	6 - 9
CTZ	◉	◉	55 - 65%	15 - 20%	7 - 10
EKUANOT® BRAND HBC 366	◉	◉	55 - 61%	14 - 17%	8 - 12
PAHTO™ BRAND HBC 682	◉	◉	68 - 75%	14 - 16%	4 - 6
MILLENNIUM	◉	◉			
MOSAIC® BRAND HBC 369	◉	◉	58 - 66%	15 - 17%	6 - 9
NUGGET	◉	◉			
SIMCOE® BRAND YCR 14	◉	◉	60 - 65%	16 - 19%	5 - 8
WARRIOR® BRAND YCR 5	◉	◉	60 - 68%	16 - 18%	4 - 7

** Actual alpha and oil percentages will vary based on lot and crop year.*
Yakima Chief Hops offers CO2 Hop Extract in full case quantities. Individual tin sales are available to customers of Country Malt Group.

Nuestros datos

Canal de YouTube
Capacitaciones El Molino

Nuestra WEB
www.capacitacioneselmolino.com

Instagram y Facebook
@capacitacioneselmolino

Consultá por nuestra MEMBRESÍA MENSUAL