

## Trends in Hop Breeding – new Aroma and Bitter Qualities at the Hop Research Center Huell

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### Objective and Results

In current breeding programs we are aiming to develop hop cultivars with specific aroma profiles and high alpha acids, respectively, which meet the demands of brewers worldwide. On the other side, by specific hybridization and selection hops should be adapted to alternative non-brewing applications.

### Aroma and High Alpha Varieties for Brewing Purposes

In the aroma sector hop cultivars are being developed which represent the classical aroma notes reflecting the noble Hallertauer Mittelfrueher and Tettnanger type and also types with distinctive flavor profiles such as in Saphir, Opal and Smaragd. We also started to breed hops with tropical, fruity or non-hoppy flavor following the trend initiated by US micro-brewers. Moreover, high alpha varieties are available which show alpha acid contents of up to 23.5 %. With this broad spectrum of hops providing various aroma notes or high alpha acids brewers can make their choice for creating special beers of distinct types and flavors.



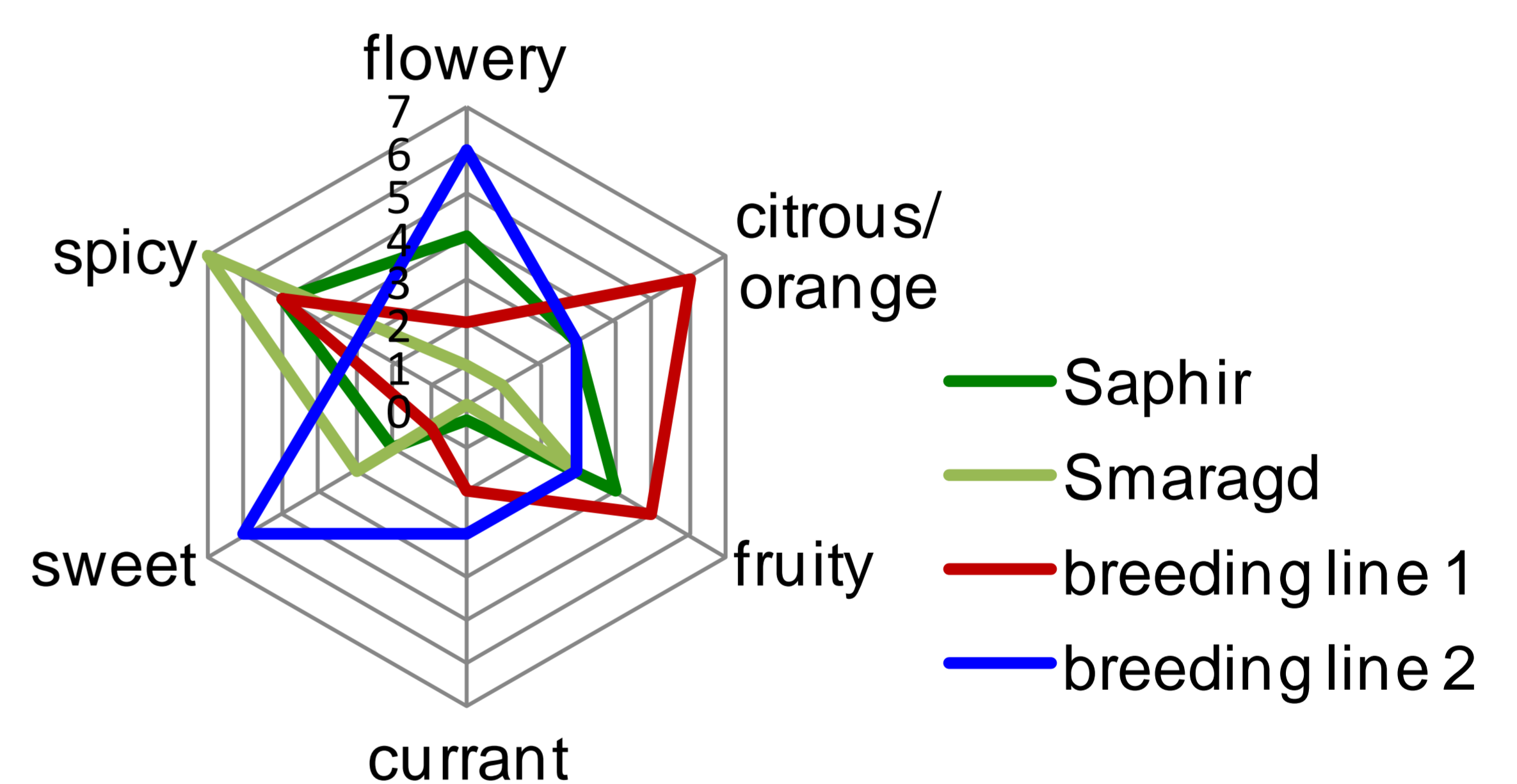
### Key Aspects of Aroma Description



|                        |  |              |               |            |            |         |
|------------------------|--|--------------|---------------|------------|------------|---------|
| <b>Purity</b>          | pure                                     |              | inhomogeneous |            | impure     |         |
| <b>Value of Flavor</b> | noble                                    | fine/mild    | medium        | unpleasant | straw-like | muffled |
| <b>Intensity</b>       | maintaining/full                         | long-lasting | medium        | weak/short | strong     | pungent |
| <b>Strange Flavor</b>  | smoky, burnt/malty, onion or garlic like |              |               |            |            |         |

|                   |                |                                |
|-------------------|----------------|--------------------------------|
| aroma flavor:     | 1 - 30 points  | bitter varieties with          |
| land races:       | 25 - 28 points | pleasant aroma: 20 - 23 points |
| aroma selections: | 24 - 28 points | pungent aroma: < 20 points     |

### Aroma Characteristics of Dried Hop Cones



### Alternative Non-Brewing Applications of Hops

Recently, breeding lines have been selected with high alpha and beta acids as well. Due to the antimicrobial and bacteriostatic effect of bitter acids these hops pave the way to new applications in the pharmaceutical and medicinal field. Furthermore, beta acids are already used as environmentally-beneficial and health-uncritical substitutes for antibiotics and formaldehyde in the food and ethanol industry. Also several Huell breeding lines showing high contents of Xanthohumol have the potential for alternative usage, since this hop prenylflavonoid has already proven anti-carcinogenic activity in various medicinal studies.

| Breeding Line or Cultivar | Alpha Acids (%) | Beta Acids (%) | Bitter Acids Total (%) | Xanthohumol (%) |
|---------------------------|-----------------|----------------|------------------------|-----------------|
| 2003/067/002              | 9.5 - 14.5      | 11.0 - 14.0    | 20 - 27                | 0.6 - 0.8       |
| 2003/067/005              | 12.0 - 16.5     | 9.0 - 12.0     | 21 - 26                | 0.6 - 0.8       |
| 2003/067/044              | 2.7 - 5.5       | 15.3 - 21.2    | 19 - 25                | 0.9 - 1.5       |
| 2001/101/704              | 10.0 - 15.0     | 3.2 - 4.7      | 13 - 19                | 1.4 - 2.1       |
| 2000/109/728              | 16.5 - 23.5     | 5.0 - 6.4      | 21 - 29                | 0.7 - 1.0       |
| Hall. Taurus              | 13.0 - 20.0     | 4.0 - 6.0      | 17 - 26                | 0.7 - 1.0       |

