Monophenols in beer

by Femke Sterckx

XIVth Chair J. De Clerck
14 September 2012
Monophenols in beer: overview

Vanilla flavour in beer
and relation with monophenols

Flavour-activity of monophenols
thresholds, interaction and effect on beer flavour

How monophenols end up in beer
origin from raw materials and wood aging
Monophenols in beer: overview

Vanilla flavour in beer
and relation with monophenols

Flavour-activity of monophenols
thresholds, interaction and effect on beer flavour

How monophenols end up in beer
origin from raw materials and wood aging
Vanilla flavour is unique for each individual

**Tasting sessions**
10 Belgian beers, 6 individuals

‘Vanilla’ descriptors
scored in all beers from 0 to 8
Vanilla flavour is unique for each individual

**Tasting sessions**
10 Belgian beers, 6 individuals

**‘Vanilla’ descriptors**
scored in all beers from 0 to 8

**Differences**
appear between individual tasters
Monophenols might be responsible for vanilla flavour

**Monophenols as flavour compounds**

Widely present in foods and beverages

In wines and spirits → vanilla, spicy flavours

4-vinylguaiacol in beer

**Identification in beer**

Screening of Belgian specialty beers

25 different monophenols

Various functional groups
Monophenols in beer: overview

Vanilla flavour in beer
and relation with monophenols

Flavour-activity of monophenols
- Flavour thresholds,
- Interactions between monophenols
- Effect on over-all beer flavour

How monophenols end up in beer
origin from raw materials and wood aging
Many monophenols have low individual flavour potential

**Thresholds of difference**
Smallest difference in concentration that can be noticed
11 compounds, from 3 ppb to 22 ppm

**Concentrations in beer fairly low**
Flavour units < 0.2

**No pronounced flavour effect**
Changing the flavour balance of the tested lager beer
Slightly softer, sweet, vanilla, spicy notes
Monophenols show predominantly positive flavour interactions

**Mixture thresholds**
Addition of 2 compounds together
Synergy <> Antagonism

**Mechanism of interaction**
similar structure
similar flavour remains unclear

**Mostly positive interactions**
9 combinations of monophenols tested:
8 positive, up to very synergetic, 1 antagonistic
Recombination experiments confirm influence on beer flavour.

**Recombinations of Belgian beers**
Difference in concentrations added to lager beer
8 and 4 monophenols added

**Triangle tests showed significant difference**
7 and 6 out of 7 correct answers

**Influence on flavour**
Even at very low concentrations
Together monophenols impart beer with vanilla, spicy flavours.
Monophenols in beer: overview

Vanilla flavour in beer
and relation with monophenols

Flavour-activity of monophenols
thresholds, interaction and effect on beer flavour

How monophenols end up in beer
- origin from plant materials
- use of different cereals for brewing
- effect of wood aging
Monophenols originate from plant material

**Phenylpropanoid pathway**
Starting from L-phenylalanine
Role in plant defence?

**Precursors of monophenols**
Lignin
Hydroxycinnamic acids
Glycosidically bound

**Occurrence in plants**
Naturally in broad variety of plants (grapes, cereals, wood…)
Widely present in foods and beverages
Monophenols in beer: overview

Vanilla flavour in beer
and relation with monophenols

Flavour-activity of monophenols
thresholds, interaction and effect on beer flavour

How monophenols end up in beer
- origin from plant materials
- use of different raw materials for brewing
- effect of wood aging
Mashing is the first step of the brewing process.
Specialty malts are often used for boiling, lautering, and mashing.
Cereal adjuncts partly replace malt
Mashing trials showed variation in monophenol content

Lab mashing trials
determining extractable amount of monophenols for 1 hour at 50 - 70°C, pH 5 - 5.5

Specialty barley malts
1 pilsner malt, 2 caramel malts, 1 roasted malt

Cereal adjuncts
barley, rice and maize flakes (processed)
rice and maize grits (broken grains)
Monophenol content differed between specialty barley malts
Monophenol content was correlated with heat treatment of specialty malts.
Monophenol content varied between cereal adjuncts.
Monophenol content was higher in maize and rice flakes.
Choice of raw materials influences monophenol content of the wort

**Increase with specialty malts**
Most monophenols related to intensity of heat treatment

**Use of cereal adjuncts**
Maize and rice flakes richer in monophenols

**Influence on beer flavour?**
Guaiacol, vanillin, 4-vinylguaiacol, eugenol
Monophenols in beer: overview

Vanilla flavour in beer and relation with monophenols

Flavour-activity of monophenols thresholds, interaction and effect on beer flavour

How monophenols end up in beer
- origin from plant materials
- use of different cereals for brewing
- effect of wood aging
Overview of the brewing process
Overview of the brewing process

- Mashing
- Lautering
- Boiling
- Cooling
- Fermentation
- Lagering
- Filtration

Cooling
Fermentation
Lautering
Boiling
Mashing
Filtration
Lagering
Wood aging is applied for some specialty beers
Addition of oak chips leads to increased monophenol concentrations

Oak chips added to bottled beer
American & French oak chips, medium and heavy toasted
stored up to 60 days (20°C)

Typical wood aged flavours
 great increase in vanilla, smoky, woody, spicy

Increase of monophenols
almost all monophenols extracted from wood into beer
Toasting level influences amount of monophenols
Different oak origins lead to differences in monophenols
Monophenols can be associated with typical wood aged flavours.
Wood aging parameters influence monophenol content

Various parameters evaluated
amount of chips, temperature, pH, ethanol content, oxygen in buffer solutions (stored for 30 days)

Wood addition during beer lagering
after main fermentation - with yeast still present lagered at 0, 4 or 20°C

Enzymatic release from wood
β- glucosidase released 3 monophenols
Vanilla flavour present in beer probably related with monophenols

Monophenols are flavour-active thresholds, interaction and effect on beer flavour

How monophenols end up in beer origin from raw materials and wood aging
General conclusions

Raw materials determine monophenol concentrations
use of special malts or adjuncts might affect beer flavour

Wood aging results in increased monophenol concentrations
& imparts beer with woody, vanilla-like, spicy flavours

Monophenols can jointly enrich beer flavour
with spicy, vanilla-like flavour notes
Acknowledgements

Prof. F. Delvaux
my promotor

the CMBS
for all the help... and the good time

IWT Vlaanderen
for financial support
Monophenols in beer

by Femke Sterckx

XIVth Chair J. De Clerck
14 September 2012