Micro-brewing learning and training program (LdV Beer School)

Sensory analysis of beer (project workshop material)

Prague, June 16.-18., 2014
Brewery School
Training and Information Centre

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Micro-brewing learning and training program (LdV Beer School)

Project Kick-off Meeting

Laško, Slovenia
February 13, 2014
Example of future education in LdV:
Which sensory properties has to have a good beer?

- pleasant characteristic smell
- high mouthfeel
- good fullness
- bitterness with a good quality
- without off-flavors

Sensory profile of beer deal together with price and package on the final success of the beer
Sensory analysis

- The most simple possibility for beginners in the brewing how to judge the quality of beer – **part of LdV program**
  - Chemical analysis – needs higher level of education and expensive analytical equipment
- A scientific discipline dealing with the evaluation of taste sensations
- Microbiology and chemical analysis is not enough quality control
- Trained degustator/taster – important position in food production
1. Introduction to sensory analysis
What is sensory analysis?

- Science discipline dealing with the evaluation of flavoured sensations
- 18th and 19th century – description of sense organs and its function
- 20th century – origin of sensorics as science discipline
Sensory analysis

- evaluation of organoleptic character of foodstuff and EXCLUSIVELY by human sense
- while maintaining the established rules → reproducible results
- objective X subjective sensory analysis
- physical, chemical X sensory analysis → external stimuli (properties) X sensations
Development of sensory analysis (in general)

- the past – suitability of foodstuff for consumption (sweet, fattiness, bitter..)
- development of civilization - the choice between dishes of varying quality → optimization of sensory quality
- the present – sensory quality is major scale during the buying
Basics of sensory analysis

• 5 basic senses:
  – olfactometric – sense of smell
  – gustatory - taste
  – haptic – touch
  – optic - vision
  – acustic - hearing
Basics of sensory analysis

• Taste
  – Solty (NaCl)
  – Sweety (sacharosa)
  – Bitter (chinin)
  – Acid (citric acid, tartaric acid..)
  – Umami (sodium glutamate)

• Smell
  – Smells perceived by nose only
Basics of sensory analysis

• Sensory threshold (stimulus threshold) – minimum value of sensory stimulus needed to give rise to a sensation

• The upper limit – the intensity of stimulated signal has not already increased

• Simultaneous effects of stimuli:
  – Antagonic effect
  – Synergic effect

  (Example: chocolate is the mixture of more than 20 sensory active compounds, no one is similar to chocolate when single)
The influence of a human individuality

• Among the people there are great differences in the perception of smell and taste (genetic factors, gender, age, etc.)

• Examples:
  – 6-n-propylthiouracil:
    - for 1/3 of population is significantly bitter
    - for 1/3 of population is a little bit bitter
    - for 1/3 of population is neutral
  – koncentrace iontů Fe:
    - for 5 % of population perceive it at concentration of 0,04 mg/l
    - for 20 % of population perceive it at concentration of 0,3 mg/l
    - for 50 % of population perceive it at concentration of 3,4 mg/l
2. Technical conditions of sensory analysis
Which factors influence the sensory sensation?

• Chemical composition of beer
  – Extract, alcohol, bitterness, sensory compounds

• Appearance
  – Colour, foam, haze

• Temperature of beer
  – Consumption 7-10 °C
  – Degustation 10-12 °C

• Gender
  – Sensitivity to some flavour could be different

• Age
  – Sensitivity to tastes doesn’t change, but is weaker

• Hunger, thirst
  – No extremes

• Daytime
  – The best time is between 10-11 AM
The conditions of precise sensory evaluation

- Selection and training of evaluators
- Anonymity of samples
- Suitable degustation room
- Neutraliser of taste
- Sampling (frequency, amount of sample..)
Selection and training of evaluators

• Physiology assumptions (verification by sensory exams)
• Psychology assumptions
• collective decision-making ability
• Regularly training
Sensory panel (committee)

- Number of members 11-15
- Minimum is 9
- More than 15 → organization troubles
- Chairman of sensory panel
  - manages a sensory sessions
  - decides about order of tests
  - chooses a type of test
  - evaluates results of tests
Anonymity of samples

• Anonymity is unconditional
• Random labeling of samples
• Identification of samples after ending of sessions
• Minimalization of influence of sensory blindness
Degustation room

- Efficient ventilation
- Stabile temperature (21 °C)
- Humidity (80 %)
- No smoking
- Floor – no carpet
- Separate boxes
- Neutral colour
- Equipment diction of the relevant legislation (in CZ – ČSN ISO 8589)
Neutraliser of taste = degustation bit

• Salami (not spicy, less salty)

• Cheese (not spicy, not aromatic)

• Bread (white)

• Right order is necessary (explanation...
Following technical conditions

• Special degustation glasses for various tests
• Size of glass
• Amount of sample
• Temperature of sample (9-11 °C)
• Number of samples (max 6-8 per hour)
• Technique design of degustation
• Regularity (ideal conditions between 10-11 AM)
3. Sensory analysis of beer
Why sensorially analyse beer?

• Chemical and microbial analysis is
  – Objective
  – Time consuming
  – Expensive (especially for microbreweries)
  – In some cases insufficient

• Training degustator will have always important position in food production
  – Evaluation of quality
  – Fast detection of technological problem

• Sensory evaluation
  – By layman
  – By trained professional
Which sensory properties has to have a good beer?

- Pleasant characteristic smell
- High mouthfeel
- Good fulness (body)
- Bitterness with a good quality
- Without off-flavours

Sensory profile of beer deal together with price and package on the final success of the beer
What is it sensorially quality/good beer?

- original function of the olfactory and taste sensations is to protect the body from receiving inappropriate or unsafe food
- current view of the quality of the beer is to be understood as a convention that developed on the basis of consumer response for a long time
- can not therefore, except mentioned limitation, generally described any beer as good or poor quality
- brewer must know what type of beer he wants to brew
Sensory profile of beer is influenced by:

- Raw material (malt, hop, water, surrogates..)
- Technology (mashing, wort boiling, fermentation, maturation, filtration and bottling)
- Conditions of storage
- Drafting/serving/tapping of beer
- Conditions of consumption
Basic characteristic of pale lager

• **Smell** - decides about the first impression of consumer about the quality of the beer
  – hop aroma, fruity-ester, yeast

• **Taste**
  – Fullness, body (in Czech chlebnatost, chléb = bread) a feeling of heaviness in the mouth; tactile sensation - is decided by mechanoreceptors
  – Mouthfeel (CO$_2$ content) – saturation of beer with carbon dioxide – in a mouth is perceived using receptors of pain
  – Bitterness – intensity, decay of bitterness, character (fine-rough)
### Organoleptic perception in beer

#### Přehled organoleptických vjemů v pivu

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<th>Organoleptický vjem</th>
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<td>z chmele</td>
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<td>z kvasnic</td>
<td>estery, vyšší alkoholy, vininální diketony, sírné sloučeniny, nížší mastné kyseliny</td>
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<td>suchá</td>
<td>kyselina mléčná, ethanol</td>
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</table>
| plná                                        | sacharidy, aminokyseliny, peptidy, β-glukany (?  
|                                             | (ne dextriny) korelace s viskozitou                                        |
| svírává (trpká, adstringentní)              | organické kyseliny, polyfenoly ?                                           |
| hřejivá                                     | alkohol, vyšší alkoholy ?                                                  |
| mazavá, olejová                             | chlorid sodný, síran sodný, glycerin?                                      |
The origin of off-flavors from malt

- GREEN GRASS - poorly stored malts (higher humidity and temperature)
- SWEET WORTY, WORTY – malt finished at higher temperature (82-83 °C)
- CARAMEL – dtto
- DMS – insufficient finished temperature of malt, low boiling during wort boiling
- PHENOLIC – smoked malt
- MUSTY – malt infected by mold
The origin of off-flavors from boiling process

- SWEETY – not fermented saccharides, peptides
- GRAINY - from barley malt (long afterwoting - too diluted afterwort, also very fine grinding of husks)
- CARAMEL, MELASA, BURNTY
  - if the temperature difference between the vessel wall and the liquid at boiling mash and wort boiling too high
  - thermal decomposition during wort boiling

CARAMEL – is typical off-flavor of dark beers, it is from caramel types of malt
The origin of off-flavors from fermentation and microbiology contamination

- FRUITY, ESTERIC, PARFUEME – native products of fermentation
- ACETALDEHYD – intermediate of transformation of sugars to alcohol
- DIACETYL – product of fermentation, elimination by technological process
- AUTOLYSIS – degradation of yeasts (dirty socks)
- SULPHURIC – (except DMS) - as cooked vegetable
  - poor elimination of deposit from hopped wort
  - MIBI contamination
The origin of off-flavors from fermentation and microbiology contamination

• as SOAP, WAX, FAT, SWEAT, FECAL
  – Fatty acids from old hop
  – MIBI contamination
  – Bad conditions of fermentation

• HYDROGEN SULFIDE (as spoiled eggs)
  – Failure of fermentation
  – MIBI contamination

• ACID – contamination by lactic or vinegar bacteria

• DMS – MIBI contamination
The origin of off-flavors by storage

- **OXIDATIVE, PASTEURIZATION, PAPPERY, CARDBOARD**
  - Storage at higher temperature, air in bottle neck

- **SKUNKY, LIGHTSTRUCK**
  - Exposure of UV (native or artificial)
  - Beer in green bottles is more at risk
4. Sensory tests used in brewery
Objective and subjective sensory analysis

• OBJECTIVE sensory analysis
  – the most accurate description and assessment of perceptions of the evaluator
  – the specification of organoleptic character of the product using a selected methodology
  – evaluations may be carried out by trained assessors only

• SUBJECTIVE sensory analysis
  – indicates the relationship of the evaluator to the evaluated product - whether he likes or dislike this product (hedonic evaluation)
  – it is necessary to distinguish whether the evaluation is performed by trained assessors or consumers who buy the product.
Sensory evaluation

... possible to translate, if speaker uses it...

Note: EBC scheme – Lecture 5
Sensory profile – see bellow
Sensory profile of beer – the example of formular used in our accredited method

Degustační arch - senzorický profil

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<td><strong>Celkový subjektivní dojem</strong></td>
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**Usage for determination of character of beer**

**Minimum number of assessors – 10**

**Statistical evaluation of obtained data** - SSSSSSSSSSSSSS

Číselná transformace: 0 - žádná, 1 - velmi slabá, 2 - slabá, 3 - střední, 4 - silná, 5 - velmi silná
Celkový subjektivní dojem: 1 - 9 (1-nejlepší, 9-nejhorší)
Sensory evaluation

Laické
- senzorická jakost
  - marketingové studie
  - spotřebitelské testy
- senzorický profil
  - degustační schéma EBC
  - 25 bodové schéma

Profesionální
- rozdílové testy
  - párová zkouška
  - trojúhelníková zkouška
  - duo - trio test
  - tetrádová zkouška
  - pořadová zkouška
- speciální testy
  - intenzita hořkosti
  - doznívání hořkosti
Discrimination tests - when are they used?

- **THE QUESTION IS:**
  - affects a technological variation (change in composition of raw materials, modification of the brewing process, changes in the fermentation) also in sensory?
  - Does exist a difference between a beer produced by the established procedure and the modified procedure?

- **CLASSICAL DESCRIPTIVE SENSORY ANALYSIS (PROFILE) FAILS TO ANSWER**
  - assessors are looking for differences according to preconceived opinion (they know what the problem is, they know what each sample represents etc.)

- **THEREFORE**
  - Such procedures are selected, that allow samples to distinguish between them or compare
Discrimination tests – Examples of usage

• Is the sample A more bitter then sample B?
• Is the sample A better then sample B?

• The selection of test (more used)
  – Paired comparison test (ČSN EN ISO 5495)
  – Triangl test (ČSN EN ISO 4120)
The example of the form for paired comparison test

Párová zkouška

Jméno:  
Datum:  

Cíl: Určení vyšší intenzity parametru

Úkol: U předložené dvojice vzorků rozhodněte, ve kterém vzorku je vyšší intenzita sledovaného parametru (podle cíle testu). Tento vzorek označte křížkem.

1  ..................  2  ..................

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podpis
Critical values for evaluation of paired comparison test

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</table>

N - celkový počet odpovědí
K - kritická veličina (minimální hodnota správných odpovědí), index označuje úroveň pravděpodobnosti
The example of form for triangle test

Trojúhelníková zkouška

Jméno: 

Datum:

Cíl: Nalezení rozdílů mezi dvěma vzorky piva

Úkol: V předepsaném pořadí dostanete tři vzorky piva. Určete, které dva vzorky jsou shodné, a který vzorek se odlišuje. Odlišný vzorek označte křížkem.

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podpis
Critical values for evaluation of triangle test

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</table>

**N** - celkový počet odpovědí

**K** - kritická veličina (minimální hodnota správných odpovědí), index označuje úroveň pravděpodobnosti
5. EBC scheme of off-flavors
Sensory scheme EBC

• There was developed an international system of descriptive terms of objective sensory evaluation of beer to ensure understanding between brewing experts all over the world.

• Organizations that participated in the development
  – European Brewery Convention (EBC)
  – American Society of Brewing Chemists (ASBC)
  – Master Brewer’s Association of the Americas (MBAA)
Circle scheme EBC
Circle scheme EBC – the mission of system

- Objective sensory evaluation of beer
- Unique terminology
- Uniform terminology
- Clear terminology
- Faultless communication between brewmasters
- Unambiguous interpretation of the results of sensory analysis of beer
Circle scheme EBC – content

• Content of 14 classess
• each separately identifiable component is characterized by a single term
• terms describing similar perceptions are placed together
• there are excluded duplicate terms
• there are not included terms of characterizing subjective approach (good - bad, rounded, not balanced, etc.)
• The meaning of terms is determined by readily available standard
Circle scheme EBC – content

• Content of 14 classes
• each separately identifiable component is characterized by a single term
• terms describing similar perceptions are placed together
• there are excluded duplicate terms
• there are not included terms of characterizing subjective approach (good - bad, rounded, not balanced, etc.)
• The meaning of terms is determined by readily available standard
Correct labeling of off-flavor

• CHEMICAL TERM - if assessor knows the chemical compound - the most accurate description (diacetyl, dimethylsulfoxide, etc.)

• TECHNOLOGICAL TERM – off-flavor reminds of some of the known processes production at the brewery (hops, wort, yeast, etc.)

• NATURAL SCIENTIFIC TERM - If the assessor does not know the chemical or taste does not resemble anything from the technological process (oxidation, burnt, sour, etc.)

• OWN TERM – usage of own imagination and taste clearly describe for the other assessors
Examples of preparation of traing mixtures of off-flavors

<table>
<thead>
<tr>
<th>Vůně nebo chuť</th>
<th>Sloučenina/postup úpravy</th>
<th>Koncentrace/čas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxid sířičitý</td>
<td>Hydrgemisřičitan draselý</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Sirovodík, zkažená vejce</td>
<td>H₂S z Na₂S₉H₆O (přípraví se čerstvý)</td>
<td>25 µg/l</td>
</tr>
<tr>
<td>Merkaptan, sůlčitá</td>
<td>Ethylmerkaptan</td>
<td>2 µg/l</td>
</tr>
<tr>
<td>Letinková</td>
<td>Pivo v průhledné láhvi</td>
<td>4 h na slunci nebo 16 hod. fluorescenční lampa</td>
</tr>
<tr>
<td>DMS, vařená zelenina</td>
<td>Dimethylsulfid</td>
<td>120 µg/l</td>
</tr>
<tr>
<td>Po rozpouštědlosech</td>
<td>Ethylacetát</td>
<td>30 – 75 mg/l</td>
</tr>
<tr>
<td>Acetaldehyd, zelená jablka</td>
<td>Acetaldehyd (čerstvě připravený)</td>
<td>20 – 40 mg/l</td>
</tr>
<tr>
<td>Esterová, banánová</td>
<td>Isoamylacetát</td>
<td>3 mg/l</td>
</tr>
<tr>
<td>Esterová, ovocná</td>
<td>Směs ethylacetátu, isoamylacetátu, ethylhexanoátu, 2-fenylacetátu a hexanoátu</td>
<td>10, 2, 0,3, 0,3 a 0,2 mg/l</td>
</tr>
<tr>
<td>Chmelová</td>
<td>Granulovaný chmel</td>
<td>pouze víně</td>
</tr>
<tr>
<td></td>
<td>Chmelová esence (např. EHP Co.)</td>
<td>100 µg/L</td>
</tr>
<tr>
<td>Květinnové</td>
<td>2-fenylisothanol</td>
<td>225 mg/l</td>
</tr>
<tr>
<td>Po koření, hřebíčku</td>
<td>Eugenol</td>
<td>1 mg/l</td>
</tr>
<tr>
<td></td>
<td>4-vinylguajakol</td>
<td>1 mg/l</td>
</tr>
<tr>
<td>Trávová</td>
<td>cis-3-hexen-1-ol</td>
<td>15 mg/l</td>
</tr>
<tr>
<td>Obilná, slámová</td>
<td>Ječmen</td>
<td>pouze víně</td>
</tr>
<tr>
<td>Sladová</td>
<td>Slad</td>
<td>pouze víně</td>
</tr>
<tr>
<td>Mladinová</td>
<td>Mladina</td>
<td>15 % do piva</td>
</tr>
<tr>
<td>Karamlová</td>
<td>Tmavý slad</td>
<td>pouze víně</td>
</tr>
<tr>
<td>Připálená</td>
<td>Pražený slad</td>
<td>pouze víně</td>
</tr>
<tr>
<td>Mastné kyseliny, žuklá, po tuku, myžlová</td>
<td>Směs kys. hexanové, oktanové a dekanové</td>
<td>3,3, 14,5 a 1,7 mg/l</td>
</tr>
<tr>
<td>Diacetylová</td>
<td>diacetyl</td>
<td>0,3 mg/l</td>
</tr>
<tr>
<td>Kvasničková</td>
<td>kvasnice</td>
<td>pouze víně</td>
</tr>
<tr>
<td>Medicinální</td>
<td>2-cholofenol</td>
<td>6 µg/l</td>
</tr>
<tr>
<td>Oxidační, stará, papírová, lepenková, po kůži</td>
<td>Pivo 38 °C nebo Pivo 45 °C, do hrdla vzduchu</td>
<td>6 až 12 dní 3 dni</td>
</tr>
<tr>
<td>Kyselá</td>
<td>Kyselina miečitá</td>
<td>600 mg/l</td>
</tr>
<tr>
<td>Alkoholová</td>
<td>Pivo 4 – 5 % alk. + vodka</td>
<td>Upravit na 7 % alk.</td>
</tr>
<tr>
<td>Příchut, prázdné</td>
<td>Sodová voda</td>
<td>20 – 30 %</td>
</tr>
<tr>
<td>Sladká</td>
<td>Suchroza</td>
<td>1,5 %</td>
</tr>
<tr>
<td>Hořkost</td>
<td>Isomerizovaný chmel. extrakt</td>
<td>30 mg/l isohumulonu nebo hořkostní řada se zvyšující se koncentrací o 5 BU</td>
</tr>
<tr>
<td>Trpká, adstringentní</td>
<td>Taannin</td>
<td>150 mg/l</td>
</tr>
<tr>
<td>Kovová</td>
<td>FeSO₄·7H₂O</td>
<td>3 mg/l</td>
</tr>
</tbody>
</table>
Spider graph

- Graphical comparison of several beers in terms of off-flavors
Paprskový (pavučinový) graf

Říz
Plnost
Hořkost
Doznívání
Trpká
Sladká
Mladinová
Kvasničná
Oxidační
Diacetyl
Esterová
Kyselá

Pivo A
Pivo B
Example of sensory laboratory

ČSN EN ISO 8589

Sensory centre
Research Institute of Brewing and Malting, Prague

www.beerresearch.cz