Basic beer style parameters – Quality Control by basic means

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This presentation serves to put Quality as a disciplin on the agenda for small breweries as the Quality function is some times perceived:

- Requiring special staff
- Time consuming
- Costly

Claim 1: Quality Control can be implemented rather cheaply.

Claim 2: But missing quality however can be costly!
The Quality Hierarchy of documentation

- Quality Policy Statement: Defines Administrative Services Approach in relation to Responsibility & Authority
- Procedures: Details HOW to do a specific detailed job function
- Work Instructions
- Quality Records

Quality Records are completed forms. Once a form is executed it then becomes a “record”
<table>
<thead>
<tr>
<th>Useful Terminology for any brewmaster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample Plan</strong></td>
</tr>
<tr>
<td><strong>Recipe</strong></td>
</tr>
<tr>
<td><strong>Process Description</strong></td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td><strong>Specification</strong></td>
</tr>
<tr>
<td><strong>Production log</strong></td>
</tr>
<tr>
<td><strong>Declaration</strong></td>
</tr>
</tbody>
</table>
Content of Sampling Plan

- Sample ID – normally a number
- Sample type – e.g. ‘boiled wort’
- Sampling point – e.g. ‘wort kettle’
- Sample amount
- Frequency – e.g. ‘daily’
- Responsible for sampling – e.g. ‘Production’ or ‘Laboratory’
- Sampling method – e.g. microbiological sample
- Analysis – verbal description, e.g. ‘iodine test’
- Analytical method – e.g. EBC Analytica
- Responsible for the analysis – e.g. ‘Production’ or ‘Laboratory’
- Logging and reporting of results – reference to QM-system
- Recipients – the direct responsible for action/approval as well as copied
## Example of Chemical Sampling Plan

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PRODUCT</th>
<th>TYPE</th>
<th>SAMPLE TYPE</th>
<th>SAMPLE FREQUENCY</th>
<th>ANALYSIS METHOD</th>
<th>SAMPLE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fermentation</td>
<td>Beer. Fermenting</td>
<td>Extract</td>
<td>Chemical</td>
<td>Daily</td>
<td>Saccharometer</td>
<td>750 ml</td>
</tr>
<tr>
<td>Beer. Fermenting</td>
<td>VDK or Diacetyl</td>
<td>Chemical</td>
<td>Each CCT, end of fermentation</td>
<td>EBC 9.24.1</td>
<td>500 ml</td>
<td></td>
</tr>
<tr>
<td>Beer. Fermenting</td>
<td>OE Alcohol pH Colour Bitterness</td>
<td>Chemical</td>
<td>Each CCT, start of cooling</td>
<td>EBC 9.4 EBC 9.2.1 EBC 9.35 EBC 9.6 EBC 9.8</td>
<td>500 ml</td>
<td></td>
</tr>
<tr>
<td>BBT</td>
<td>Filtered beer</td>
<td>OE (+RDF) alcohol pH Colour CO₂ Dissolved oxygen Haze Taste</td>
<td>Chemical, sensory</td>
<td>Each BBT</td>
<td>EBC 9.4 + 9.5 EBC 9.2.1 EBC 9.35 EBC 9.6 EBC 9.28.2 EBC 9.37 EBC 9.29</td>
<td>500 ml</td>
</tr>
</tbody>
</table>
# Example of Microbiological Sampling Plan

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PRODUCT</th>
<th>TYPE</th>
<th>SAMPLE TYPE</th>
<th>SAMPLE FREQUENCY</th>
<th>ANALYSIS METHOD</th>
<th>SAMPLE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging, glass bottles</td>
<td>Beer before filler</td>
<td>Total counts (CFU)</td>
<td>Microbiological</td>
<td>Dynamic</td>
<td>DEV Nähragar NBB bouillon</td>
<td>Min. 8 l container</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beer spoilage organisms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Packaged beer flash</td>
<td>Total counts (CFU)</td>
<td>Microbiological</td>
<td>At start and each change</td>
<td>DEV Nähragar NBB bouillon</td>
<td>2 contain.</td>
</tr>
<tr>
<td></td>
<td>pasteurised only</td>
<td></td>
<td></td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shelf life</td>
<td></td>
<td></td>
<td>Weekly Check</td>
<td></td>
<td>1 contain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Washed bottles for</td>
<td>Total counts (CFU)</td>
<td>Microbiological</td>
<td>Weekly</td>
<td>DEV Nähragar NBB bouillon</td>
<td>8 contain.</td>
</tr>
<tr>
<td></td>
<td>aseptic filling</td>
<td>Beer spoilage organisms</td>
<td></td>
<td>Dynamic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CIP</td>
<td>Last rinse water</td>
<td>Total counts (CFU)</td>
<td>Weekly</td>
<td>DEV Nähr agar</td>
<td>100 ml</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or Beer spoilage organisms</td>
<td>Microbiological</td>
<td>Dynamic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example of the simplest production log: Brewhouse log

8:50 Mashing in 45°C
9:30 45 → 64°C
9:42 64°C
10:15 add cold water 2 l
10:31 iodine - starch
10:34 76°C → 80°C
10:40 pH = 5.7
10:59 under let ting
11:06 empty mash kettle
11:22 run-off SG = 1.074 18.5% PL
12:00 sparging
12:45 wort in kettle 13.5% Pl.
17:20 boil → 14:20
Example of a production log: Idealised fermentation chart

Fermentation control: Temperature and % Plato during fermentation: Allows the Brewer to spot slow fermentations and when fermentation has ended. Cost and effort: Almost nothing.
More completed Fermentation Chart: Included some actions and some QC data

Day
Date
Temperature, °C
% Plato
pH
Operation
Yeast count, 10^6/ml
Diacetyl, ppb

Day Zero is calculated from "Pitched volume".

Yeast Count = (J x B x C) / (A x 100)
What to measure?

• Chemical parameters (Alcohol, Colour, Bitterness)
• Microbiology (level of infection, pitching yeast standard)
• Raw material checks (malt, hops, glass bottles)
• Flavour (positive flavors and off – flavors)
• Packaging quality (fill level, labelling standards)
• Customer satisfaction (product shelf life)
• Manufacturing logs:
  • Raw materials used
  • Mashing diagrams
  • Fermentation logs
  • Samples taken / analysed
Example of Wort chemical Analysis - basic

<table>
<thead>
<tr>
<th>SG (App)</th>
<th>SG (Prol)</th>
<th>BU</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01372</td>
<td>1.014379</td>
<td>17</td>
<td>13.165</td>
</tr>
<tr>
<td>1.01318</td>
<td>1.014181</td>
<td>28</td>
<td>13.165</td>
</tr>
<tr>
<td>1.01363</td>
<td>1.01841</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>1.01383</td>
<td>1.01872</td>
<td>26</td>
<td>13.351</td>
</tr>
<tr>
<td>1.01396</td>
<td>1.02001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RDF: 61.5 - 65.5%
Only 7 chemical parameters define our Basic Beer Style and - Quality

1) Original Extract OG [% P] g/100 g

2) Color EBC Units

3) Haze 20 °C EBC Units

4) Real Degree of Fermentation RDF [%]

5) pH [number]

6) Alcohol by Volume ABV [%] ml/100 ml

7) CO₂ [%] g/100 ml
These 7 chemical parameters can all be measured in the brewery by simple means.
The brewer’s choices

1. Basic instruments: Cheap

2. Basic instruments: Costs < 2000 €

3. Portable instruments: Costs > 2000 €
Crushed Malt after the mill – often forgotten

Visual examination of crushed malt enables checks for:

• whole kernels (should not be there !)
• That all kernels are squeezed
• Some flour – not too much
Brewhouse test: Iodine test
Shows, whether the mash has converted

Reaction mixture shows a positive test for starch
[Blue-black color]

Cavity tile

Iodine solution [Brown]

Amylosehelice with the glucose-monomerunit:

O
H

O
H

O
H

O
Extract analysis in spent grains:
Shows whether we obtain the extract from the malt

Example of a spent grains press
Saccharometer
**Refractometer:**
Shows OG of wort

Accuracy: +/- 0.2 % P
Obs.: Other limitations; but convenient

Microbrewer using refractometer

Refractometer, hand held

Refractometer, Lab. Bench type
**Saccharometer**
Shows OG of wort

Accuracy: +/- 0.1 % P
Use of Saccharometer in practice
as seen still in many breweries

Time consuming – very manual
**Pycnometer**
Show OG of wort

**Methods with highest accuracy:**

Densitometry using Pycnometry

Accuracy: +/- 0.03 % P
**pH – meter**

Used for control of mashing – and wort boiling pH control

**Accuracy:** +/- 0.1 pH

Lab bench pH - meter

Students measuring wort pH
More Brewhouse tests

For check of efficiency of wort boil:

Break formation measured by an Imhoff cone

For check of fermentation start:

Wort aeration checked by a simple flow meter
...and some packaging tests, simple, yet useful
some are rarely seen used...

Humidity test - labels
Air in headspace test
Glue test
**CO₂-measurement of bottled beer**

to ensure same pressure in each bottle

Fast – not so accurate
Taste testing: A Powerfull Quality – and Diagnostic Tool to reveal process defects

Taste test scores:

<table>
<thead>
<tr>
<th>Glass</th>
<th>Normal</th>
<th>Oxid.</th>
<th>Light</th>
<th>Diasc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flavour Term</th>
<th>Associated Fault</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malty</td>
<td>Raw malt, wort clarity</td>
<td>Improve boil/trub removal</td>
</tr>
<tr>
<td>Warty</td>
<td>Wort clarity, Wort boiling, poor fermentation</td>
<td>Improve Process</td>
</tr>
<tr>
<td>Caramel</td>
<td>Dark malt, sugars, over boiling</td>
<td>Grist &amp; check boil</td>
</tr>
<tr>
<td>Burnt</td>
<td>Dark malt, over boiling</td>
<td>Grist &amp; check boil</td>
</tr>
<tr>
<td>Grainy</td>
<td>Raw malt, Grist fineness, brewhouse cond.</td>
<td>Grist, sparge temp &amp; pH</td>
</tr>
<tr>
<td>DMS</td>
<td>Malt quality, boil &amp; whirlpool, yeast infection</td>
<td>Change malt, increase boil</td>
</tr>
<tr>
<td>Bitter</td>
<td>Hop rate, sulphite ions</td>
<td>Decrease both or either</td>
</tr>
<tr>
<td>Hoppy</td>
<td>Higher alcohols, hop type, hope rate</td>
<td>Alter hop rate</td>
</tr>
<tr>
<td>Cheesy</td>
<td>Old oxidised hop</td>
<td>Change hops</td>
</tr>
<tr>
<td>Lightstruck</td>
<td>Clear/green glass bottles</td>
<td>Browning</td>
</tr>
<tr>
<td>Estery Fruity</td>
<td>High fermentation temperature, excess oxidation</td>
<td>Increase temp and O2</td>
</tr>
<tr>
<td>Estery Apple</td>
<td>Inadequate fermentation</td>
<td>Improve yeast growth: yeast food, oxygen, temp.</td>
</tr>
<tr>
<td>Diacetyl</td>
<td>Inadequate fermentation</td>
<td>Improve yeast growth: yeast food, oxygen, temp.</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Wild yeast, clarifiers, high sulphate</td>
<td>Hygiene, process control</td>
</tr>
<tr>
<td>Mealtan</td>
<td>Autolised yeast</td>
<td>Remove yeast promptly: temp control</td>
</tr>
<tr>
<td>Phenolic</td>
<td>Wild yeast, chlorine from brewing or breakdown liquor, detergent residues</td>
<td>Hygiene, process control</td>
</tr>
<tr>
<td>Catty</td>
<td>Oxygen particularly during packaging</td>
<td>Oxygen control</td>
</tr>
<tr>
<td>Acidic</td>
<td>Infection, low PG. Added mineral acids</td>
<td>Hygiene, farm control</td>
</tr>
<tr>
<td>Astringent</td>
<td>Principally oxidised polyphenols: or hops</td>
<td>Higher cut off gravity, lower sparge temp, hop rate</td>
</tr>
<tr>
<td>Metallic</td>
<td>Metal pickup from plant &amp; materials</td>
<td>Plant audit</td>
</tr>
<tr>
<td>Alcoholic</td>
<td>Higher alcohol's - metabolism &amp; temp</td>
<td>Better temp control</td>
</tr>
<tr>
<td>Sweet</td>
<td>Priming, poor attenuation's, poor conversion</td>
<td>Less fermentable residue</td>
</tr>
<tr>
<td>Mouthfeel</td>
<td>Residual polypeptides &amp; carbohydrates</td>
<td>Change attenuation</td>
</tr>
</tbody>
</table>
The brewers choices

1. Basic instruments: Cheap

2. Basic instruments: Costs < 2000 €

3. Portable instruments: Costs > 2000 €
The microscope – cheap, yet powerful

Microscope found in the brewmaster’s Office next to his PC.

Acetic Acid bacteria found in draft beer from a brewery.
Microscope

Body Tube

Revolving Nosepiece

Objectives

Stage Clips

Diaphragm

Light Source

Ocular Lens (Eyepiece)

Arm

Stage

Coarse Adjustment Knob

Fine Adjustment Knob

Base

20-09-2016
“FermentoFlash” – example of a fast way of obtaining a chemical beer analysis

- Alcohol (% v/v & w/w)
- Extract – real & apparent
- Original gravity
- Density
- Osmotic pressure

Accuracy: +/- 0.02 % ABV

- Degassing of sample
- 10 ml sample
- Analysed in 1 minute
- Printer or PC
- Calibration with reference beer (up to 18 different)
- Prize: ~ 2000 € + VAT

www.funke-gerber.de
The brewer’s choices

1. Basic instruments: Cheap
2. Basic instruments: Costs < 2000 €
3. Portable instruments: Costs > 2000 €
Portable Density Meter to achieve fast and accurate chemical parameters

- Density
- Specific gravity
- Extract
- Alcohol
- Viscosity 0 – 1000 mPa*s
- Temperature compensated 0 – 40°C

Sample: 2 ml
Time: Few seconds
Price: Approx. 2000 €

www.anton-paar.com
Portable CO$_2$ / DO Measurement

to measure Oxygen take-up during production

Several suppliers

Anton Paar – CarboQC
www.anton-paar.com

Dr. Thiedig – Digox
www.thiedig.com

Pentair’s CO$_2$ Gehaltemeter
www.Pentair.com
Lab. bench Methods – accurate, not cheap

High accuracy (do You need it?)

Densitometry using automatic apparatuses

(most common is PAAR densitometer based on ultrasonic vibrations. The PAAR unit may be a stand-alone or may be built into an automatic complete wort analyzer called a SCAWA)
Automised micro methods

Beckman Coulter: Vi-Cell
viabilitet by Trypan Blue staining in flow cell

Aber instruments: Lab Yeast Analyzer:
Viability by. capacitans metering

Chemometec: NucleoCounter
viabilitet by iodine staining

20-09-2016
Customer’s satisfaction – some times forgotten

1. Do You know, what your customers think of your beers in trade?

2. Winning beer competitions is nice, but your everyday customer pays your income

3. Do You systematically collect complaints statistics and use complaints for process improvements?
Conclusion:

Quality can be managed and product consistency achieved even on a small Budget and using limited efforts!

Thank you for your attention!

Axel G. Kristiansen