Blackcurrant wine and vinegar

Effects of processing methods on content of beneficial polyphenols – a pilot study

by

PhD Kimmo Rumpunen
Researcher and plant breeder of black currant and sea buckthorn
Breeding of black currants in Sweden

- Programme restarted in 2006 (based on previous long term breeding efforts)
- The breeding programme is aimed at developing cultivars primarily for organic black currant growing
- Plants are grown in the north (at Öjebyn) and in the south of Sweden (at Balsgård) – aiming at 2000 plants every second year
Breeding of black currants, objectives

- **Powdery mildew resistance** (screening in greenhouse and in the field)
- **Gall mite resistance** (new DNA-markers and protocol available)
- **Black currant reversion virus resistance** (new RT-PCR protocol available for virus detection)
- **Leaf curling midge** resistance (new sources identified!)
- **Field tolerance against** *septoria, antrachnose, white pine blister rust* (annual screening)
Breeding of black currants, objectives

- Mechanical harvesting, organic growing (erect plants, proper berry size, strong skin)
- Annual and high yield (plants being adapted to the climate in the north and south, winter and spring frost tolerance)
- Mild typical black currant taste
- High content of ascorbic acid
- High content of anthocyanins
- High content of total phenols
Some recent selections

**BRi0711-54.** For fresh market.
Very sweet, pleasant aroma, big berries, easy pick, very healthy leaves.

**BRi0702-154.** Intended for processing.
High yield, dry pick, no fruit drop, nice plant shape, healthy foliage. Potential resistance against gall mite.
Research projects associated with the black currant breeding programme

• *Climafruit*. Transnational project between the berry industry and research organisations in Sweden, Norway, Denmark, Germany and Scotland 2009–2013. *Organic and conventional field trials at Balsgård. EU/Interreg.*

• *Ontogenetic and genetic effects on health-promoting compounds in black currants (buds, leaves and fruits).* PhD research project 2010–2013. SLF.

• *Intensified quality-breeding of blackcurrants for northern Sweden.* 2012–2014. RJF.
Background: Why black currant wine and vinegar?

- Black currants have a pleasant aroma and are rich in polyphenols, especially anthocyanins.
- Polyphenols, among them antocyanins – may improve the function of arteries and have several other health benefits.
- Different fermentation approaches may increase bioavailability of polyphenols – eg lactobacilli can metabolise polyphenols.
- Harmful effects of easily metabolised carbohydrates – significantly reduced during fermentation.
- Vinegar consumption – may delay gastric emptying and improve glycaemia.
Background: polyphenols in commercial fruit wines

<table>
<thead>
<tr>
<th>Source of fruit wine</th>
<th>Sample size</th>
<th>Total phenols (mg GAE/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabernet (grapes)</td>
<td>6</td>
<td>2005a</td>
</tr>
<tr>
<td>Elderberry</td>
<td>5</td>
<td>1753a</td>
</tr>
<tr>
<td>Blueberry</td>
<td>6</td>
<td>1676a</td>
</tr>
<tr>
<td>Black currant</td>
<td>6</td>
<td>1509a</td>
</tr>
<tr>
<td>Cherry</td>
<td>6</td>
<td>991b</td>
</tr>
<tr>
<td>Raspberry</td>
<td>6</td>
<td>977b</td>
</tr>
<tr>
<td>Plum</td>
<td>4</td>
<td>555bc</td>
</tr>
<tr>
<td>Apple</td>
<td>6</td>
<td>451c</td>
</tr>
<tr>
<td>Chardonnay (grapes)</td>
<td>6</td>
<td>287c</td>
</tr>
<tr>
<td>Riesling (grapes)</td>
<td>6</td>
<td>250c</td>
</tr>
</tbody>
</table>

(Vasantha Rupasinghe and Clegg, 2007, J Food Comp Anal)
Materials and methods for black currant wine and vinegar study

- Frozen black currant berries
- Four different processing methods for purée preparation
- Standardised method for fermentation of wine
- Standardised method for fermentation of acetic acid
- Analysis of total phenols, total anthocyanins, total sugars and titratable acidity
- Analysis of major anthocyanins and rutin through HPLC-DA
## Puree preparation

<table>
<thead>
<tr>
<th>Puree 1</th>
<th>Puree 2</th>
<th>Puree 3</th>
<th>Puree 4 (mash)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen berries, wash with hot (55°C) tap water</td>
<td>Frozen berries, wash with hot (55°C) tap water</td>
<td>Frozen berries, wash with hot (55°C) tap water</td>
<td>Frozen berries, wash with hot (55°C) tap water</td>
</tr>
<tr>
<td>Grind</td>
<td>Grind</td>
<td>Grind</td>
<td>Grind</td>
</tr>
<tr>
<td>Enzymatic treatment (Klerzyme 0.3 ml/kg, 50°C, 1 h)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Heat 80°C, 15 min, then cool</td>
<td>Heat 80°C, 15 min, then cool</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Strain,</td>
<td>Strain</td>
<td>Strain</td>
<td>–</td>
</tr>
<tr>
<td>Store at 8°C over night</td>
<td>Store at 8°C over night</td>
<td>Store at 8°C over night</td>
<td>Store at 8°C over night</td>
</tr>
</tbody>
</table>
Alcohol (wine) fermentation

- Puree was diluted 1:1 with water
- Soluble solids adjusted to 7° Brix with dextrose.
- Rehydrated yeast (S. cerevisiae) and yeast nutrients were added at 30°C
- Fermentation took place at 24°C.
- Dextrose was added daily during the first four days corresponding to a total amount of 17°Brix.
- Fermentation continued for 7 days then filtration through a 1 mm net was done.
- The wine was then kept at 8°C for another 14 days for sedimentation and was then decanted.
Vinegar (acetic acid) fermentation

- A submerged method was used
- Air was forced through the black currant wine by use of aquarium pumps, PVC pipes and filter to obtain fine bubbles
- Acetic acid bacteria were pre-cultured in diluted wine
- Acetic acid fermentation continued for 10 days at 28°C.
Quantified polyphenols

1 = Delphinidin-3-O-glucoside; 2 = Delphinidin-3-O-rutinoside; 3 = Cyanidin-3-O-glucoside; 4 = Cyanidin-3-O-rutinoside; 5 = Rutin

![Graph showing quantification of polyphenols at 520 nm and 360 nm wavelengths.]

Chemical structures of delphinidin and cyanidin with respective substitutions.
# Phenols and anthocyanins in puree (diluted with water 1:1)

<table>
<thead>
<tr>
<th></th>
<th>Puree 1</th>
<th>Puree 2</th>
<th>Puree 3</th>
<th>Mash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenols (mg GAE/L)</td>
<td>3506 ± 101</td>
<td>3361 ± 152</td>
<td>2549 ± 21</td>
<td>2349 ± 72</td>
</tr>
<tr>
<td>Total anthocyanins (mg/L)</td>
<td>457 ± 25</td>
<td>466 ± 7</td>
<td>474 ± 27</td>
<td>467 ± 25</td>
</tr>
</tbody>
</table>
Specific polyphenols in purée (diluted with water 1:1, mg/L)
## Alcohol and acidity of the wine

<table>
<thead>
<tr>
<th></th>
<th>Wine 1</th>
<th>Wine 2</th>
<th>Wine 3</th>
<th>Wine 4 mash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol (vol)</td>
<td>9.1 ± 0.3</td>
<td>9.2 ± 0.0</td>
<td>9.4 ± 0.0</td>
<td>9.9 ± 0.2</td>
</tr>
<tr>
<td>Acidity (as citric acid, g/100 mL)</td>
<td>4.82 ± 0.03</td>
<td>4.79 ± 0.04</td>
<td>4.63 ± 0.02</td>
<td>4.46 ± 0.02</td>
</tr>
<tr>
<td>pH</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Specific polyphenols in wine (% compared to puree)

Total polyphenols: 65–80% left

Total anthocyanins: 61–79% left
## Acidity of the vinegar

<table>
<thead>
<tr>
<th></th>
<th>Vinegar 1</th>
<th>Vinegar 2</th>
<th>Vinegar 3</th>
<th>Vinegar 4 mash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>3.9 ± 0.4</td>
<td>3.9 ± 0.1</td>
<td>4.1 ± 0.3</td>
<td>4.0 ± 0.2</td>
</tr>
<tr>
<td>Total acidity</td>
<td>5.4 ± 0.4</td>
<td>5.4 ± 0.1</td>
<td>5.5 ± 0.3</td>
<td>5.4 ± 0.2</td>
</tr>
<tr>
<td>(as acetic acid, g/ 100 mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Specific polyphenols in vinegar (% compared to puree)

Total polyphenols: 80-105% left

Total anthocyanins: 25-32% left
Conclusions

- It is possible to ferment black currant berries into wine and vinegar with a high content of polyphenols, though the wine will be very acidic.
- Alcohol fermentation decreased the content of all polyphenols – however a large amount remains in the wine.
- Acetic fermentation further decreased the content of anthocyanins.
- Rutin seems to be quite resistant to degradation during fermentation compared to the anthocyanins.
- The pre-fermentation processing of fruits significantly influenced the content of total phenols in the puree.
- The different treatments of the puree did not significantly affect the content of acetic acid or total acidity of the vinegar.
Acknowledgement

This study was enabled due to the joint efforts of

Meike Paschke¹, Gerhard Flick¹, Michael Rajeev Vagiri², Anders Ekholm² and Kimmo Rumpunen²

¹Neubrandenburg University of Applied Science, Department of Food Science- and Bioprocess Technology, Germany

²Swedish University of Agricultural Sciences, Department of Plant Breeding and Biotechnology, Plant Breeding Horticulture, Balsgård, Sweden