Composition and Health Properties of Blackcurrant; A Nordic Perspective

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Optional Strategies of Blackcurrant processing

- **herbal tea**
  - dried spice
  - spice extract
  - herbal remedies

- **leaves**
  - buds
  - branches

- **berries**
  - pressing
  - nectars
  - jams
  - jellies
  - sauces

- **press residue**
  - waste

- **dried residue**
  - food fiber
  - cutin for plastics
  - phenolic extracts
  - bakery products
  - extrudates
  - food color
  - lecithin

- **residues**
  - toxins
  - foreign materials

- **juice**

- **berry wine**

- **seed oil**
  - CO₂ extraction of seed oil
  - pre-treatment, stabilization, refining, milling

- **Various technologies**
The Presentation Includes Examples of Analysis (1), Properties of Extracts (2) and Extrudates (3), and Effects of Seedoil (4)

- **spice extract** (1)
- **leaves buds branches**
- **berries**
- **pressing**
- **press residue**
- **waste**
- **Various technologies**
- **phenolic extracts** (2)
- **extrudates** (3)
- **CO₂ extraction of seed oil**
- **seed oil**
- **CO₂** (4)

- **berry wine**
- **juice**
- **nectars jams jellies sauces**
- **dried residue**
- **food fiber cutin for plastics**
- **phenolic extracts**
- **bakery products extrudates food color lecithin residues toxins foreign materials**
- **pre-treatment, stabilization, refining, milling**
- **dried spice spice extract**
- **herbal tea herbal remedies**
- **herbal remedies**
- **herbal tea dried spice spice extract**
- **Various technologies**
- **Various technologies**
(1) Analysis of Phenolic Compounds of BC (Leaves)

- Buds and leaves of three varieties
- 'Mikael', 'Mortti', No 15
- Phenolic compounds (HPLC-DAD-ESI-MS/MS)
- Contents defined, HPLC-DAD

- 'Mortti' and No 15 were alike. 'Mikael' was different.
- Flavonolglycosides the major phenolic group
- Tannins (proanthocyanidins) and phenolic acids less abundant

Liu, Kallio, Yang
Food Chemistry 2014, 160, 180-189
Flavonol Glycosides Form the Most Abundant group

HPLC-DAD chromatogram of leaves (variety ‘Mikael’). 70 % H₂O-acetone extraction, measured at 280 nm.

Liu, Kallio, Yang
*Food Chemistry* 2014, 160, 180-189
Changes in flavonoglycosides in BC leaves in 2011 and 2012.

Liu, Kallio, Yang
Food Chemistry
2014, 160, 180-189
Quercetin-3-O-(6''-malonyl)-glucoside is a significant compound in BC

- Qu-3-O-(6''-malon)-glc in BC leaves 120-230 mg/100 g fw
- High bioactivity
  - Known to lower blood glucose
  - Lowers risk of coronary clogging
  - Lowers oxidation of LDL
- Phenolic compounds have an effect on flavor and color
- Highest activities in leaves after berry harvesting!

The same methods of analysis to be applied in analysis of leaves, berries, food products, human tissues, blood, urine, feces etc.

→ Useful in food chemistry, technology, nutrition, medicine

Liu, Kallio, Yang
Food Chemistry
2014, 160, 180-189
(2) Antioxidant Potential of Blackcurrant Press Residue Extracts

Extrusion

press residue

Extr I

Extr II

Extr III

Extr IV

EtOH 92 %

Antioxidant activity:
- TRAP
- ORAC
- DPPH

Phenolics:
- Folin-C
- Acy-glyc
- Flav-glyc
- Phen Ac

HPLC
Methods Applied in Analysis of the Antioxidant Potential

- **Juice pressing** by hydraulic press (no enzymes)
- **EtOH (92 %) extraction** of press residues + filtration (four consecutive extr.)
- **Filtration**, dilutions
- **Folin-Ciocalteu** reagent reducing capacity ("P.-C. phenolics")
- **TRAP** (Total Radical-Trapping Antioxidant Parameter, luminometric)
- **ORAC** (Oxygen Radical Absorbance Capacity, fluorometric, Excitation 485 nm, emission 535 nm)
- **DPPH** (DPPH –radical trapping, reduction of violet at 515 nm)
- **HPLC phenolic profile** (anthocyanins, flavonols, phenolic acids)
Profiles Obtained by Different Methods Give Different Results

FOLIN-CIOOC.

ORAC

TRAP

Gallic acid equivalent, umol/L

Trolox equivalent, umol/L

Trolox equivalent, umol/L

Extract I
Extract II
Extract III
Extract IV

Blackcurrant
Hawthorn and sea buckthorn have both high specific ORAC values.

All currants are close to each other.

SB (S) and SB (N) are close to each other but separated by TRAP.
Differences between Extract I and Extract IV in Various Berries

Specific TRAP in the first extracts (I) is higher than in the last extracts (IV), with one exception only - SB(N).

The last extracts (Extr IV) have always higher specific ORAC values than the first extracts (Extr I).

→ Composition and properties of the extracts vary based on the raw material and extraction time.

→ TRAP and ORAC (and DPPH etc.) measure different compositional qualities.

SB(N) = sea buckthorn, north
SB(S) = sea buckthorn, south
BC = blackcurrant
GC = greencurrant
RC = redcurrant
WC = whitecurrant
HW = hawthorn
EMB = Indian goosberry
No single method of analysis gives a universal answer of the antioxidative activity/capacity of a product. Even the combination of three methods does not give reliable result concerning the biological/nutritional effects of the product. The measurements are reliable and repeatable – let us investigate the chemistry behind these values!

Interpretations?

SB(N) = sea buckthorn, north
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Phenolics:
- Folin-C
- Acy-glyc
- Flav-glyc
- Phen Ac

Antioxidant activity:
- TRAP
- ORAC
- DPPH
(3) Blackcurrant Press Residue as Raw Material in Extruded Snacks

Extrusion

Press residue

Extraction I

Extr II

Extr III

Extr IV

EtOH 92 %

Phenolics:
- Folin-C
- Acy-glyc
- Flav-glyc
- Phen Ac

Antioxidant activity:
- TRAP
- ORAC
- DPPH

HPLC

?
Exploiting blackcurrant juice press residue in extruded snacks

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ABSTRACT
Extrusion process was developed to exploit blackcurrant juice press residues from industrial side-streams. Press residues obtained from conventional enzymatic pressing, with high content of fiber and seed oil, and novel non-enzymatic juice processing, with high content of sugars, fruit acids and anthocyanins, were extruded with barley flour, oat flour or oat bran. The recipes consisted of blackcurrant press residues (30%), cereal materials (40%) and potato starch (30%) and small amount of sugar and salt. When compared to enzymatic press residue and oat bran, the novel non-enzymatic press residue extruded with barley or oat flour had higher expansion, lower hardness and density, higher redness (a*), lower pH, and higher contents of fructose, glucose and fruit acids, all contributing positively to liking of texture, appearance, and flavor as well as berry-like experience. These characteristics were obtained with more gentle processing parameters, consisting of a lower total mass flow, screw speed and barrel temperature. Female consumers gave lower ratings in flavor, appearance and overall pleasantness for blackcurrant snacks than males. The study presented a sustainable way of utilizing industrial press residues from different processes of berry juice pressing for production of healthy snacks and breakfast cereals.
Fig. 1. Five parallel pictures of the samples: enzymatic residue (ER) extrudates A. ER-barley, B. ER-oat and C. ER-oat bran; non-enzymatic residue (NR) extrudates D. NR-barley, E. NR-oat and F. NR-oat bran.
Fig. 2. Hardness values (N/mm; averages of triplicate measurements, 9–10 replicates) of the extrudates: (○) ER-barley, (×) ER-oat, (■) ER-oat bran, (▲) NR-barley, (●) NR-oat and (+) NR-oat bran (A) and reference products: (●) Reference 1, (■) Reference 2, (▲) Reference 3, (×) Reference 4 B. The force (compressive load; N) needed for probe to penetrate to certain depth (compressive extension; mm) into the extrudate. ER-oat bran had 2–9 replicates in compressive extensions 0.8–3.0 mm.
Fig. 3. PCA bi-plot of physical properties of the extrudates and reference products (References 1–4). The physical properties are presented in blue, reference products in red and extrudates in brown font. Abbreviations of physical properties refer to Table 3. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
• No organic solvents
• No heat stress of raw materials or products
• Aseptic extracts possible
• CO₂ atmosphere during processing
• Environmental-friendly
• Often no further refining of the products needed
• Major applications are natural lipids and natural aroma compounds / perfumes

• Heavy investments needed
• If small facilities, high production costs
• Limited selectivity
• Technically most feasible modifiers not always practical
• Oils comparable with “non-refined” or “virgin”
• International growth has been slow – why?

(4) Examples of Biological Effects of BC Seed Oil Extracted by Supercritical CO₂
Composition of Currant Seed Oils Vary Based on Species, Varieties and Growth Conditions

Fatty acids in acyl glycerols and other fat soluble bioactive compounds of BC seed oil are assumed to be related to the health-beneficial effects in man.
Correlations of FAs in Alpine and Red Currant Seed Oils

Table 3 Correlation coefficients between the polyunsaturated fatty acids of alpine currant and northern recurrant seed oil

<table>
<thead>
<tr>
<th></th>
<th>Alpine currant</th>
<th>Northern recurrant</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Linoleic acid</td>
<td>γ-Linolenic acid</td>
</tr>
<tr>
<td>γ-Linolenic acid</td>
<td>-0.76*</td>
<td>-</td>
</tr>
<tr>
<td>α-Linolenic acid</td>
<td>-0.27</td>
<td>0.16</td>
</tr>
<tr>
<td>Stearidonic acid</td>
<td>-0.72*</td>
<td>0.65</td>
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* Significant at P %<0.05; ** significant at P <0.001
Blackcurrant seed oil for prevention of atopic dermatitis in newborns: a randomized, double-blind, placebo-controlled trial

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Summary

Background The present increased incidence of atopic diseases has been associated with an altered intake of essential fatty acids (EFAs). The composition of blackcurrant seed oil (BCSO) corresponds to the recommended dietary intake of EFAs, and as a dietary supplement could, in small doses, modify the imbalance of EFAs in an efficient way.

Objective To assess the effect of dietary supplementation with BCSO on the prevalence of atopy at 12 months of age.

Methods Three hundred and thirteen pregnant mothers were randomly assigned to receive BCSO (151) or olive oil as placebo (162). The first doses were administered at 8th–16th weeks of pregnancy and were continued until the cessation of breastfeeding, followed by supplementation to the infants until the age of 2 years. Atopic dermatitis and its severity (SCORAD index) were evaluated. Serum total IgE was measured and skin tests were performed at the age of 3, 12 and 24 months.

Results Parental atopy was common (81.7%) among study subjects, making them infants with increased atopic risk. There was a significantly lower prevalence of atopic dermatitis in the BCSO group than in the olive oil group at the age of 12 months (33.0% vs. 47.3%, P = 0.035). SCORAD was also lower in the BCSO group than in the olive oil group at 12 months of age (P = 0.015). No significant differences in the prevalence of atopic dermatitis were observed between the groups at the age of 24 months (P = 0.18).

Conclusion Dietary supplementation with BCSO was well tolerated and it transiently reduced the prevalence of atopic dermatitis. It could therefore be one potential tool in the prevention of atopic symptoms when used at an early stage of life.

(Registration number SRCTN14869647, http://www.controlled-trials.com)
BC oil enhances innate and adaptive immunity via breast milk cytokines

Black currant seed oil supplementation of mothers enhances IFN-γ and suppresses IL-4 production in breast milk

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Keywords
atopic dermatitis; breast milk; cytokines; fatty acid; intervention

Abstract
Background: The first year of infancy is crucial for the development of atopic immune response. Inadequate early Th1 and Th2 responses and increased production of Th2 cytokines are associated with atopy. Breast milk contains several immunomodulatory cytokines and other factors that might influence the maturation of the infant’s immune system. We assessed the cytokines in breast milk of mother of newborn infants and their associations with black currant seed oil (BCSO) supplementation during pregnancy, mother’s atopic status and the development of infant’s dermatitis.

Methods: Mothers and infants from an intervention study by black currant seed oil (n = 31) or olive oil as placebo (n = 30) were included in the study. Breast milk samples were collected during the first 3 months of breastfeeding. Breast milk levels of IL-4, IL-5, IL-10, IL-12, IFN-γ and TNF were measured by Luminex technology.

Results: BCSO intervention group had decreased level of IL-4 (p = 0.044) and elevated level of IFN-γ (p = 0.014) in breast milk as compared to olive oil group. No significant differences were observed in IL-5, IL-10, IL-12 and TNF levels between the BCSO and olive oil groups. Mothers who had atopic dermatitis had significantly decreased levels of IL-10 (p = 0.044) in breast milk. Breast milk of the mothers of the children who developed atopic dermatitis had lower levels of IFN-γ (p = 0.039) as compared to the breast milk of the mothers of the children without dermatitis.

Conclusion: Dietary intervention with BCSO had immunomodulatory effects on breast milk cytokine production towards Th2 to Th1 immunodeviations.

Linnamaa et al. Pediatric Allergy and Immunology 2013, 24, 562-566
Breast milk concentrations (pg/ml) of mothers undergoing BSCO (black, n=31) and olive oil (white, n=30) intervention

**IL-4**
- p=0.036
- Interleukin 4 is a cytokine regulator in immunity
- Decreases production of IFN-gamma
- Overproduction associated with allergies

**IL-5**
- p=0.39
- Associated with allergic rhinitis (inflammation of nose mucose membranes) and asthma

**IL-10**
- p=0.76
- Pleiotropic effects in immunoregulation and inflammation
- Inhibits synthesis of IFN-gamma

**IL-12**
- p=0.76
- Stimulates production of IFN-gamma
- Reduces IL-4 mediated suppression of IFN-gamma
- Anti-angiogenic activity

**IFN-γ**
- p=0.022
- Interferon γ is a dimerized soluble cytokine
- Secreted by T helper cells
- Antiviral, immunoregulatory, anti-tumor properties
- Pro-inflammatory
- Leds to cellular immunity
- Critical for innate and adaptive immunity

**TNF**
- p=0.14
- Group of apoptosis-indicing cytokines

**Obs!** This trend should be taken into account even though p is high

Modified from:
Linnamaa et al.
Pediatric Allergy and Immunology
2013, 24, 562-566
Also other metabolites, e.g. aroma/flavour compounds, phenolics, sugars, acids, cutins etc. have been investigated at UTU.

Fig. 1 Taxonomic classification of the 22 berry species investigated.
PUBLICATIONS CONCERNING CURRANT BERRIES (*Ribes*) (by FoodChem and FoodDevel, UTU May 05th 2014)


Thank you!