Apple juices: How to increase the polyphenol diet while keeping the taste quality for consumers?

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To cite this version:

Claudia Mariana Castillo Fraire, Jean-Michel Le Quéré, Sophie Guilois-Dubois, Pascal Poupard, Claudia Mariana Castillo Fraire, et al.. Apple juices: How to increase the polyphenol diet while keeping the taste quality for consumers?. 3rd Fruit & Vegetable Processing Symposium 2020, Nov 2020, Avignon, France. hal-03326107

HAL Id: hal-03326107
https://hal.inrae.fr/hal-03326107
Submitted on 25 Aug 2021

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Apple juices: How to increase the polyphenol diet while keeping the taste quality for consumers?

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\textbf{F&V Processing 2020 – November, 24-25\textsuperscript{th}, 2020}
Polyphenol contribution in apple juices: the fair balance between nutritional & sensorial qualities

**Health benefits of polyphenols in food**

Antioxidant, anti-inflammatory, cell signaling effects, actions on microbiota...


**Sensory contribution**

**Bitterness**

A flavor as a consequence of direct interaction with specific receptors in the mouth

**Astringency**

roughness and dryness in the mouth, A « tactile » sensation

Linked to precipitation of salivary proteins by tannins

Detrimental for consumer (if too high)
From the fruits... to the juices: the main polyphenol categories in apple

Clear juice

Eating and dessert apples

Categories in the Flesh

Hydroxycinnamic acids

\[
R = \text{OH} : \text{caffeoylquinic acid} \\
R = \text{H} : \text{p-coumaroylquinic acid}
\]

Catechins

\[
R_1 = \text{OH}, R_2 = \text{H} : (-)-epicatechin \\
R_1 = \text{H}, R_2 = \text{OH} : (+)-catechin
\]

Dihydrochalcons

\[
R = \text{glucose} : \text{phloridzin} \\
R = \text{xyloglucose} : \text{phloretin xyloglucoside}
\]

Procyanidins and condensed tannins

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Crushing • Pressing • Clarification • Filtration

Mainly extracted from the flesh

Weakly concentrated in the flesh of eating apples
**Polyphenols in the currently marketed apple juices**

**Experimental**

Detailed polyphenol profiles for **32 commercial apple juices** of the French market

HPLC-UV-MS coupled & phloroglucinolysis (triplicates)

Assay of total procyanidins (including polymers)

**Main results**

Distribution according polyphenol classes

- **Hydroxycinnamic acids**
  - Number of juices: 12, 11, 3, 2, 0, 0, 0, 1
  - Concentration range: 0.75-125 mg/L

- **Catechins**
  - Number of juices: 18, 7, 2, 1, 0, 1, 0, 2
  - Concentration range: 0.15-15 mg/L

- **Procyanidins**
  - Number of juices: 16, 5, 2, 4, 0, 0, 0, 2
  - Concentration range: 0.15-15 mg/L

- **Total Dihydrochalcones**
  - Number of juices: 16, 8, 3, 0, 1, 0, 0, 1
  - Concentration range: 0.15-15 mg/L

**Total polyphenols**

0.2 g/L

The averaged apple juice

- Hydroxycinnamates: 36 mg/L
- Catechins: 25 mg/L
- Procyanidins: 19 mg/L
- Dihydrochalcones: 123 mg/L

**Experimental**

**Main results**

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**Total polyphenols**

0.2 g/L
Which ways to increase polyphenol contents

Juices made from eating apples

Limiting the during losses during extraction of the juice by avoiding oxidation, rapid processing)

In most cases: increased levels of «high polymerised procyanidins»

Excessive increase of astringency and/or bitterness
Alternative: the use of polyphenol-rich varieties:
The cider apples

Dessert apples

In the Flesh

Cider apples

Polyphenol concentration in (g/kg FW)

- 1 2 3 4 5 6 7 8

Dessert apples:
- Braeburn
- Golden delicious
- Gala
- Granny Smith
- Belchard

In the Flesh:
- Petit Jaune
- Binet Rouge
- Clozette
- Avrolles
- Dous Moen
- Antoinette
- Bedan
- Dabinett
- Dous Coet Ligné
- Chevalier Jaune
- Kermerrrien
- Jeanne Renard

Polyphenol concentrations include:
- Catechins
- Procyanidins and condensed tannins
- Hydroxycinnamic acids
- Dihydrochalcones

Sanon et al., 1999
et Guyot et al., 2002
Cider apple clear juices:
- 3 cider varieties
- 4 conditions of mash oxidation (OX0, OX1,..)

**Apple varieties**
- ▲ Kermerrien
- ■ Guillevic
- ♦ Dous moen

**Polyphenol assays**
- 1. Large removal of the polyphenols from the juices by **adsorption on the pomace**
- 2. Oxidative conversion of native polyphenol into “neoformed” oxidation products (not assayed by HPLC but may account for 30% of total polyphenols)

**Sensory analysis**
- Astringent

**Decrease of astringency according to oxidation level**

From Renard, Le Quéré J.-M., Symoneaux et al., Food Chem., 2011
Oxidative conversion of native polyphenols into neoformed oxidation products… the example of chlorogenic acid oxidation products

Chlorogenic acid

Radical scavenging activity
(DPPH method, TEAC molar values)

Wong-Paz et al., lwt, 2015

- Various polyphenols structures which still have “in vitro” antioxidant properties
- Several dozens of mg/L in cider apple juices (unpublished)
An experimental action of apple juice tasting at International Agricultural Fair (Paris)

Blending of 3 cider varieties (bitter, sweet, acidulous)

- 10 times more concentrated!
- One serving (150 ml) : 200 mg flavonoïds

10 JUICES

Total polyphenol (g/L)

350 consumer tastings

Appreciation rating (from 0 to 10)

Petit Jaune (Acidulous)

Marie Ménard (bitter)

Douce Moen (sweet)

Age class (every), sex (every), n= 244
Conclusion

- High quality apple juices could be obtained by blending of cider apple varieties (including “very high polyphenol level” varieties) in combination to a controlled oxidation during processing.

- Further studies are needed for a better control of oxidation and understanding its consequences on juice quality.
  - Kinetic study of the oxidation of polyphenol and oxygen consumption.
  - Chemical structures and quantification of polyphenol oxidation products
  - Nutritional and sensory properties of those neoformed polyphenols
Thank you for your attention!

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