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

Claudia Mariana Castillo Fraire, Jean-Michel Le Quéré, Sophie Guilois-Dubois, Pascal Poupard, Claudia Mariana Castillo Fraire, Sophie Guilois, Sylvain Guyot

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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-03326107v1>

Submitted on 25 Aug 2021

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



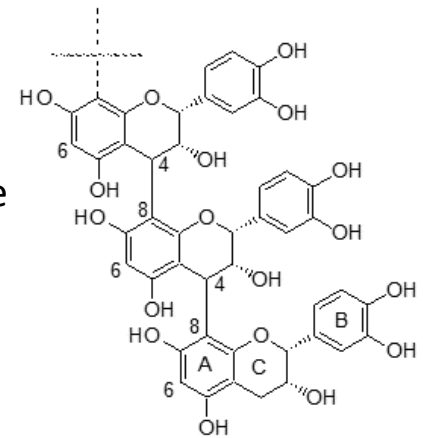
Pascal POUPARD^{2,3}, Claudia Mariana CASTILLO FRAIRE^{1,3}, Jean Michel LE QUERE^{1,3},
Sophie GUILOIS^{1,3}, Sylvain GUYOT^{1,3},

¹ INRAE, UR BIA, PRP Team (Polyphenols, Reactivity & Process), 35653 Le Rheu, France

² IFPC, Institut Français des Productions Cidricoles, 35653 Le Rheu, France

³UMT Actia Nova²Cidre

(sylvain.guyot@inrae.fr)



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...



Beneficial effects on risk of cancers, cardiovascular diseases, asthma, and Alzheimer's disease (Hyson, D.A. Adv. Nutr. 2: 408–420, 2011)

200 mg/day of total flavonoids: the lowest risk of all-cause mortality (Liu, al. Mol. Nutr. Food Res.,2017)

Sensory contribution

Bitterness

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

Astringency

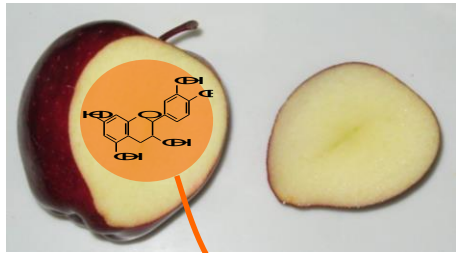
roughness and dryness in the mouth, A « tactile » sensation



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



Eating and
dessert
apples

- Crushing
- Pressing
- Clarification
- Filtration

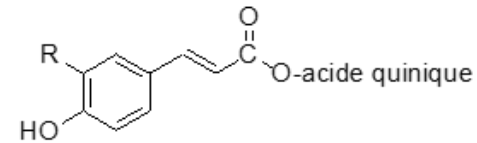


Clear juice

*Mainly
extracted
from the
flesh*

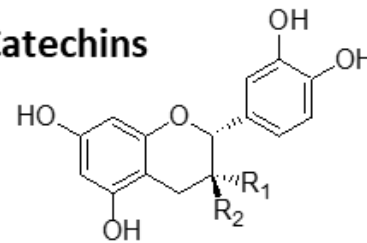
Categories in the Flesh

Hydroxycinnamic acids



R = OH : caffeoylquinic acid
R = H : p-coumaroylquinic acid

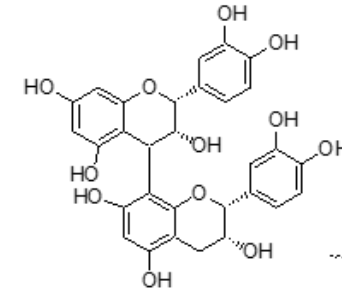
Catechins



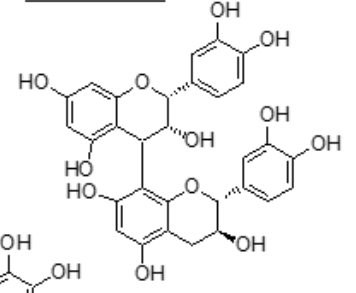
R1=OH, R2 = H : (-)-epicatechin
R1=H, R2=OH : (+)-catechin

Procyanidins and condensed tannins

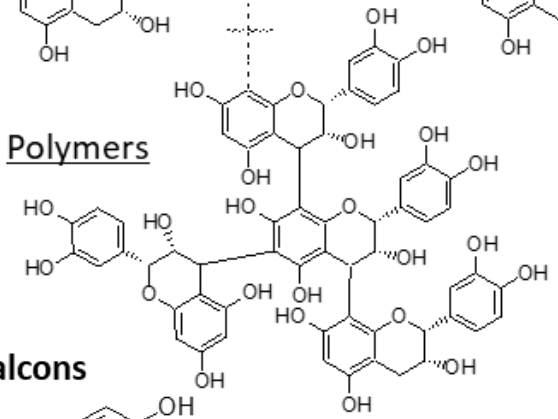
B2 dimer



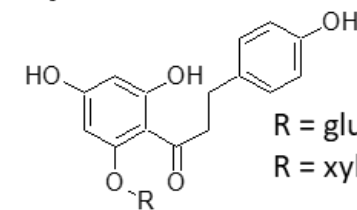
B1 dimer



Polymers



Dihydrochalcones



R = glucose : phloridzin
R = xyloglucose: phloretin xyloglucoside

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)

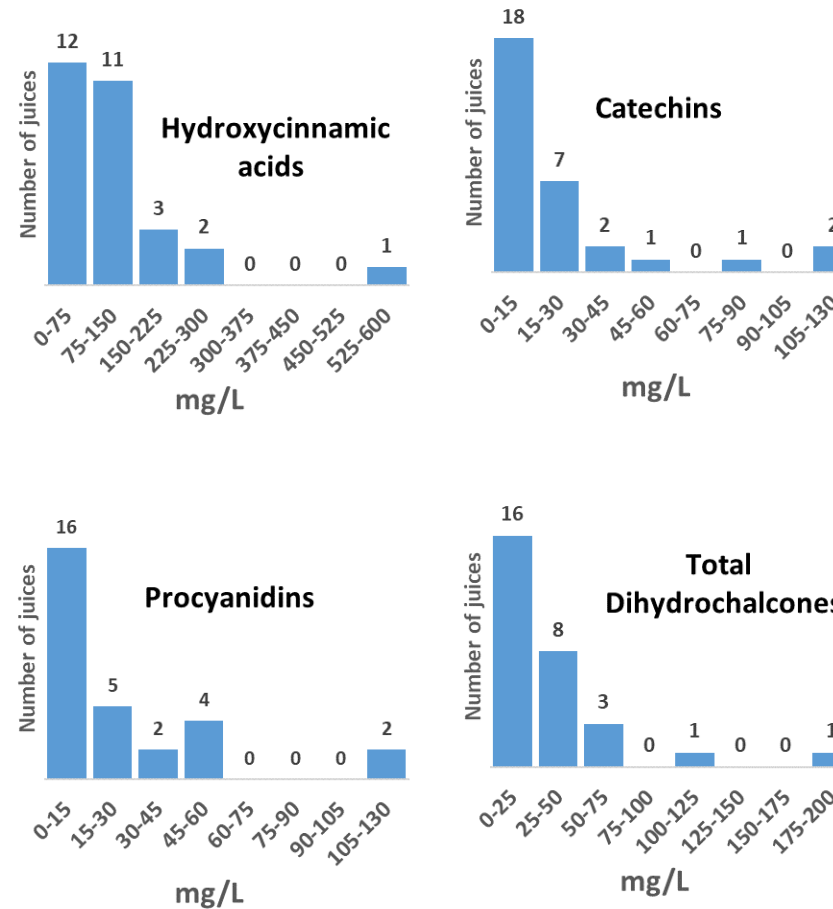


Assay of total procyanidins (including polymers)

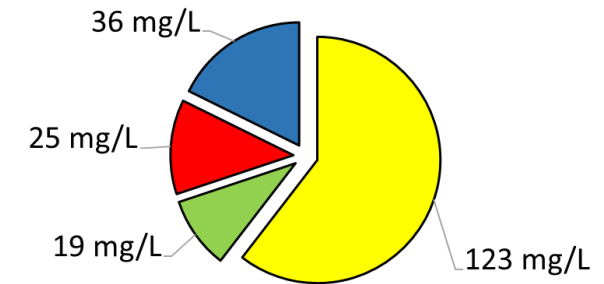


Main results

Distribution according polyphenol classes



The averaged apple juice



- Hydroxycinnamates
- Catechins
- Procyanidins
- Dihydrochalcones

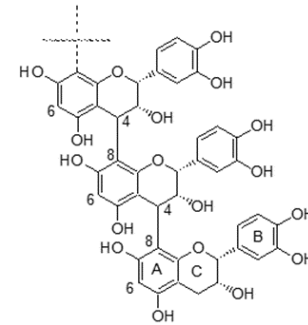
Total polyphenols
0.2 g /L

Which ways to increase polyphenol contents

Juices made from eating apples

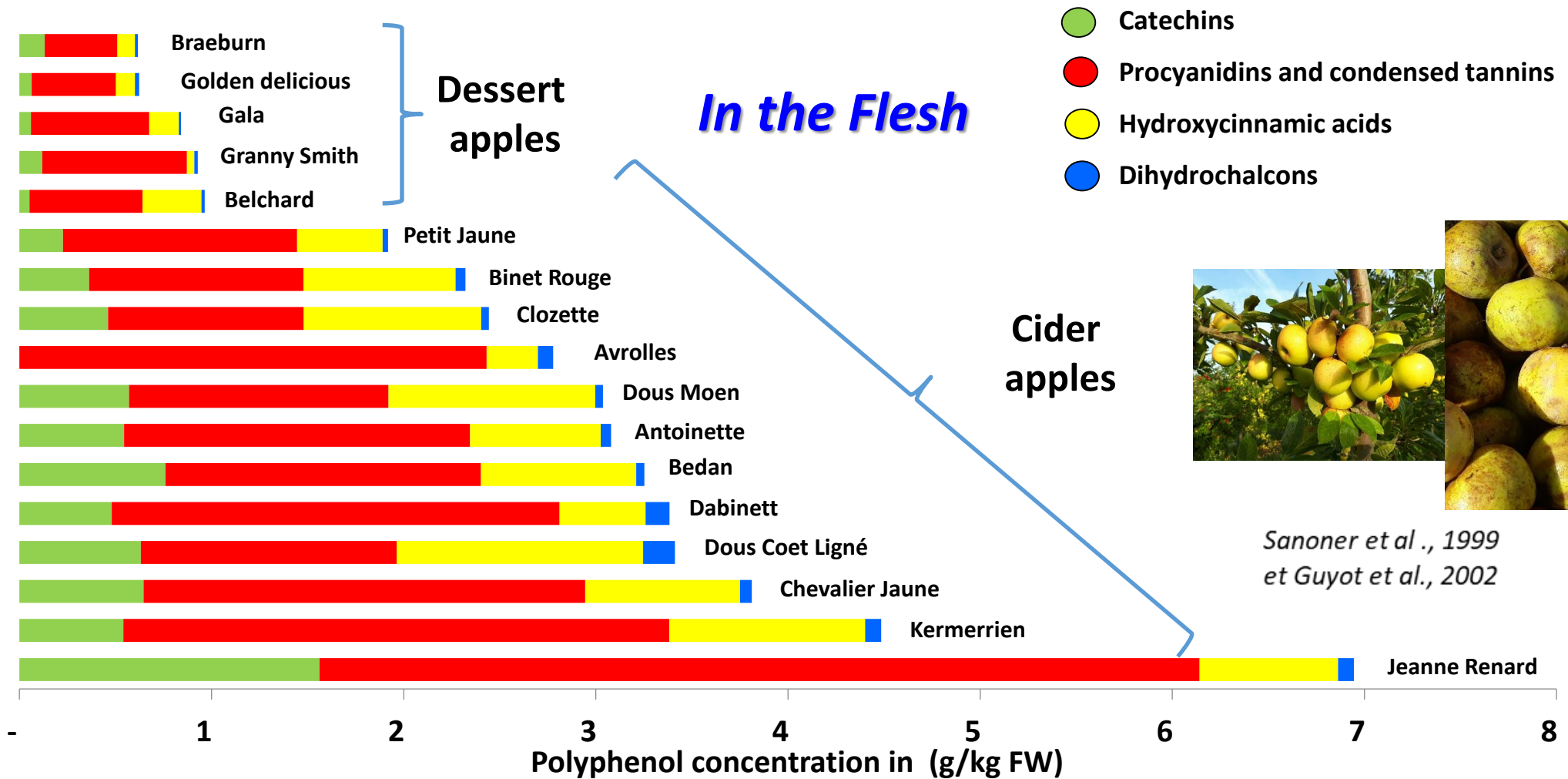
Limiting the during losses during extraction of the juice by avoiding oxidation, rapid processing)

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





Cider varieties processed in controlled oxidative conditions

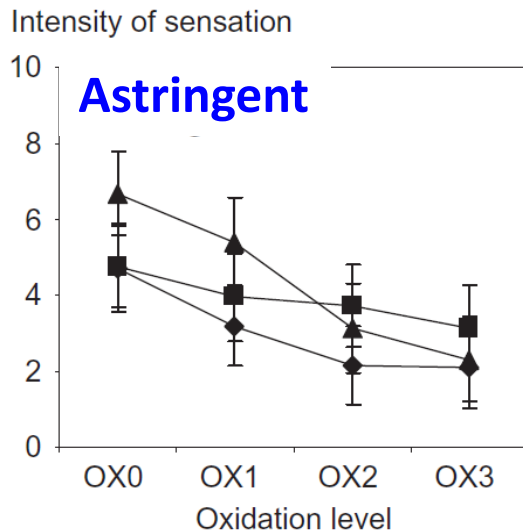
Cider apple clear juices :

- 3 cider varieties
- 4 conditions of mash oxidation (OX0, OX1,...)

Sensory analysis

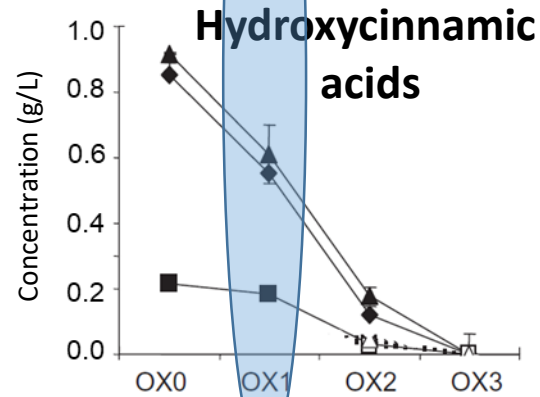
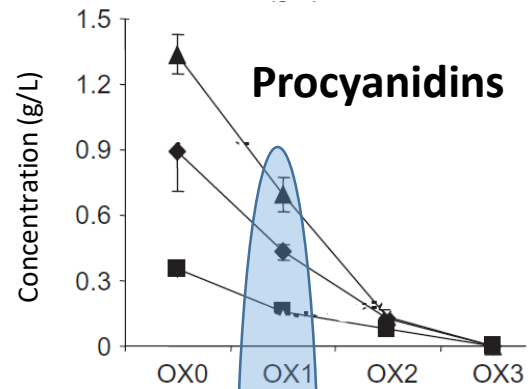
Apple varieties

- ▲ Kermerrien
- Guillevic
- ◆ Dous moen



Decrease of astringency according to oxidation level

Polyphenol assays



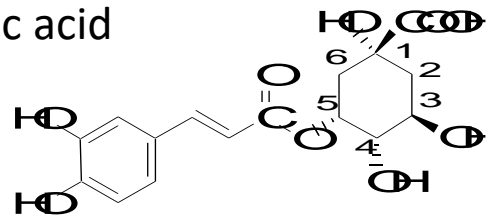
Classical practice in French cider making

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)

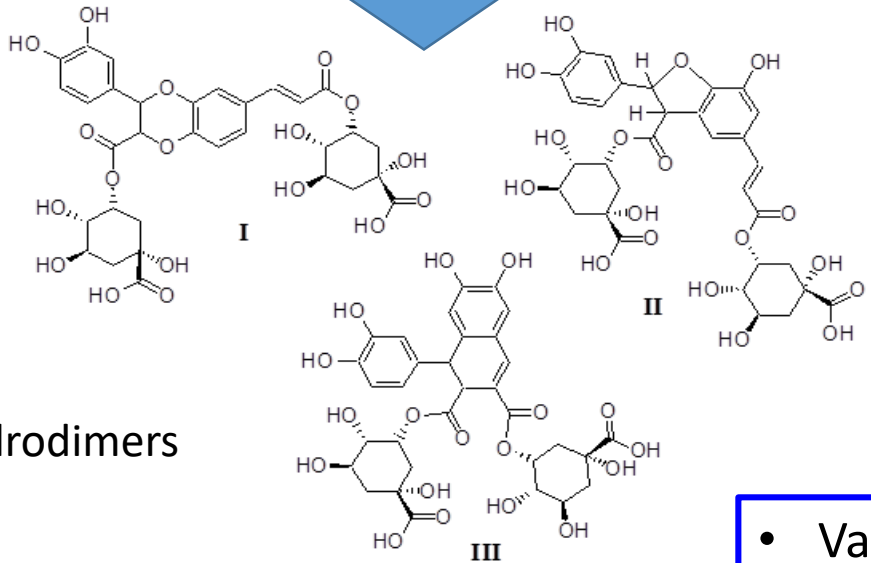
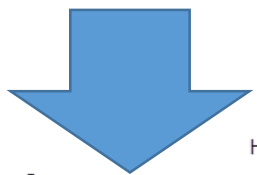
Oxidative conversion of native polyphenols into neoformed oxidation products...the example of chlorogenic acid oxidation products

Chlorogenic acid



PPO

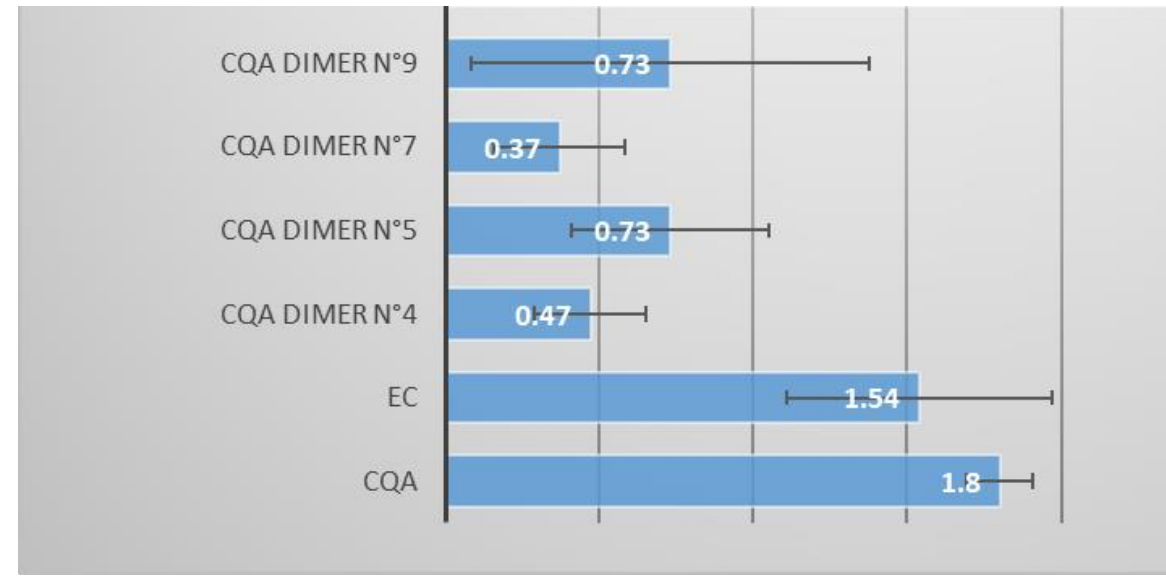
O₂



Dehydrodimers

Radical scavenging activity
(DPPH method, TEAC molar values)

Wong-Paz et al., Iwt, 2015



Bernillon et al., Rap. Com. Mass Spectr., 2004
Castillo-Fraire et al., J. Chrom A., 2019

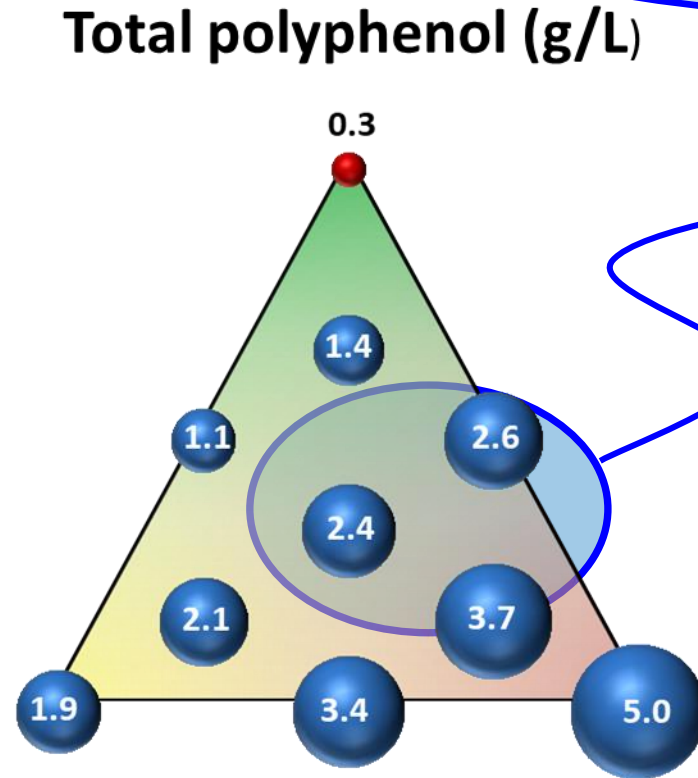
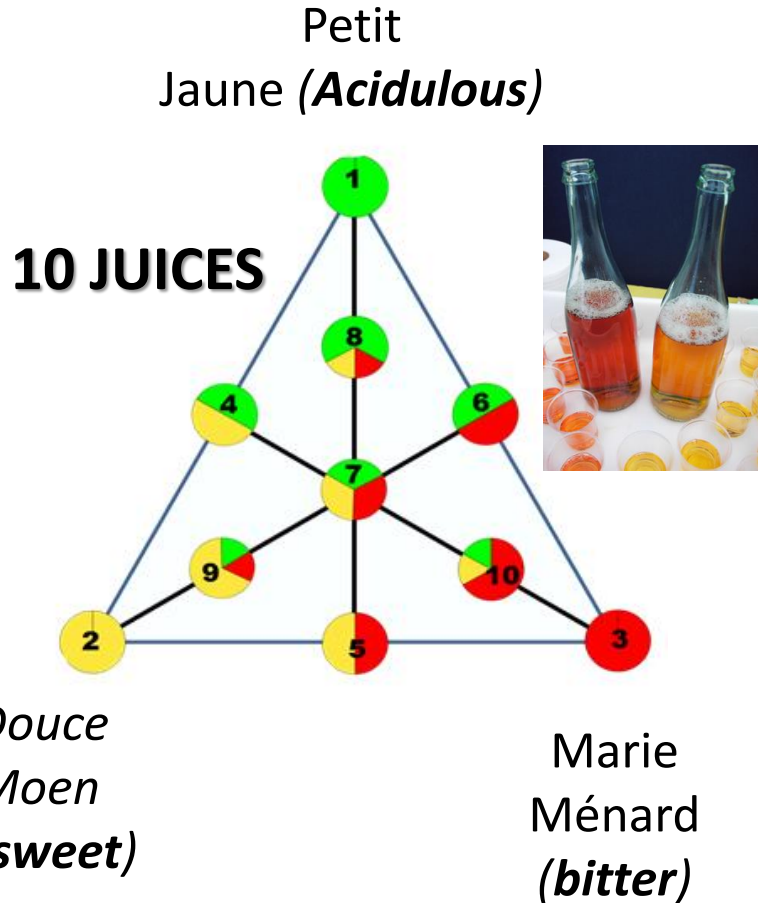
- Various polyphenols structures which still have “in vitro” antioxidant properties
- Several dozens of mg/L in cider apple juices (*unpublished*)

An experimental action of apple juice tasting at International Agricultural Fair (Paris)

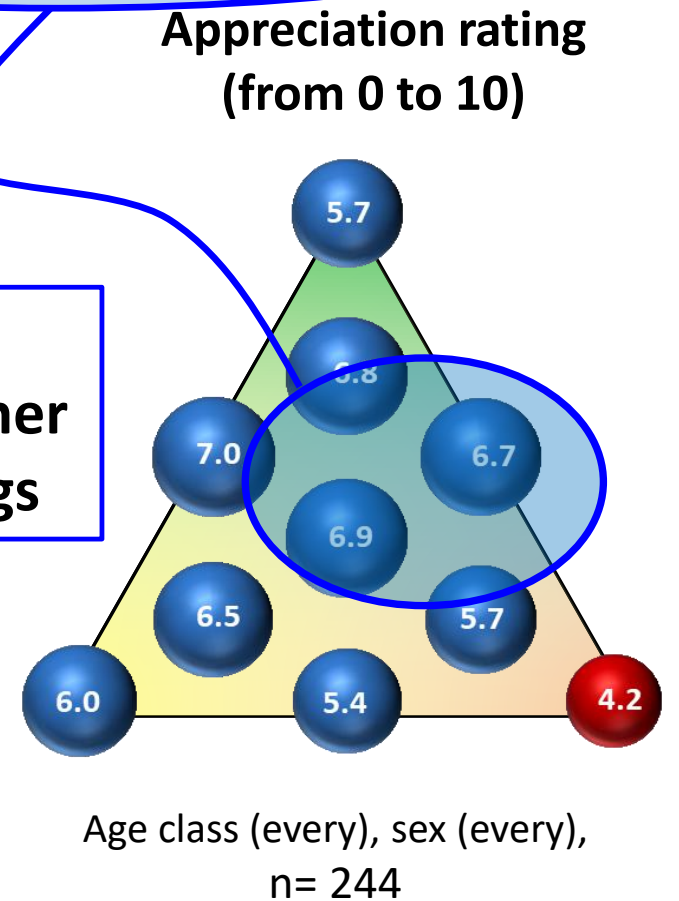


Blending of 3 cider varieties
(bitter, sweet, acidulous)

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



350 consumer tastings



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 !



F&V Processing 2020 – November, 24-25th, 2020