



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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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

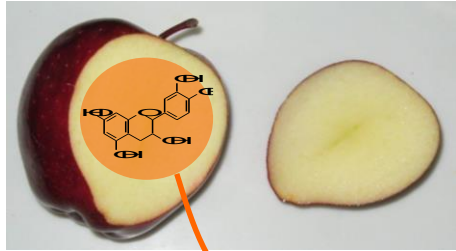
roughness and dryness in the mouth, A « tactile » sensation



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

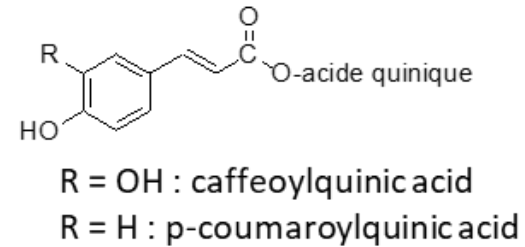


*Mainly
extracted
from the
flesh*

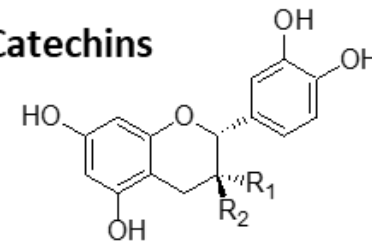
Clear juice

Categories in the Flesh

Hydroxycinnamic acids



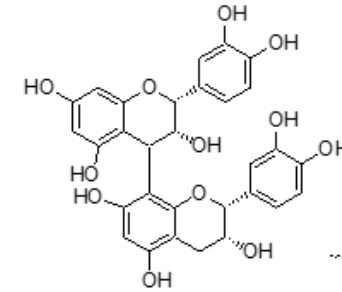
Catechins



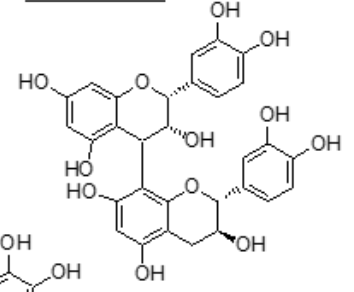
R1=OH, R2 = H : (-)-epicatechin
R1=H, R2=OH : (+)-catechin

Procyanidins and condensed tannins

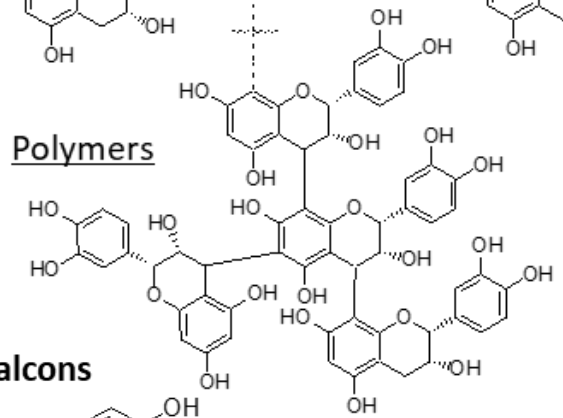
B2 dimer



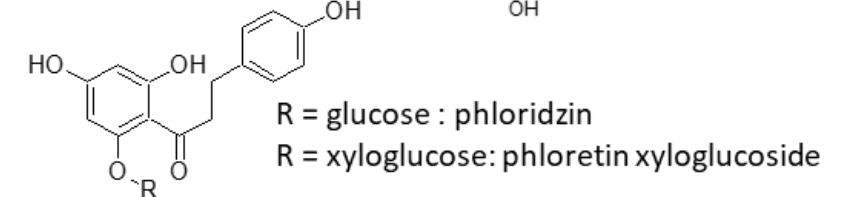
B1 dimer



Polymers



Dihydrochalcones



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)

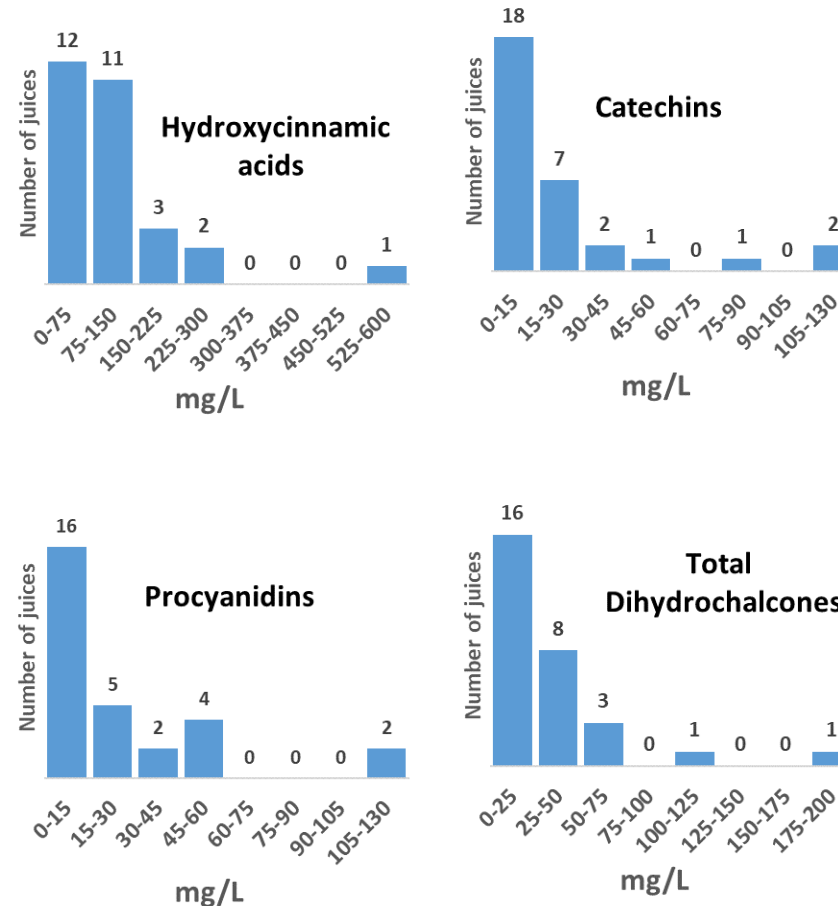


Assay of total
procyanidins (including
polymers)

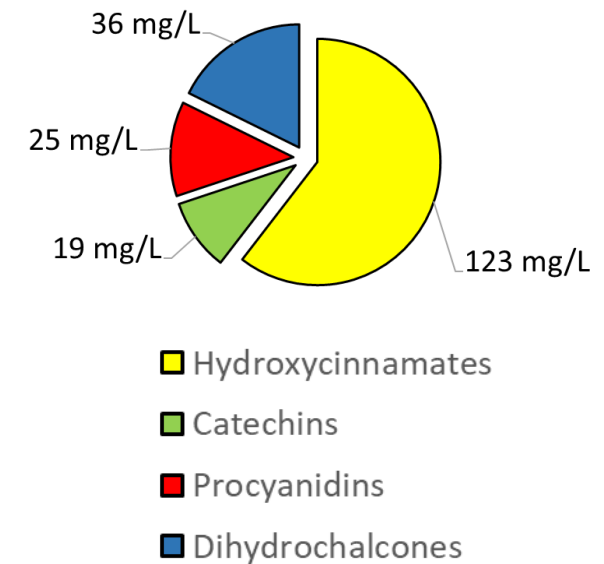


Main results

Distribution according polyphenol classes



The averaged apple juice



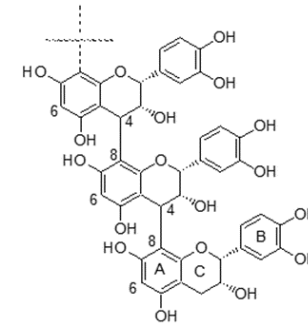
Total polyphenols
0.2 g /L

Which ways to increase polyphenol contents

Juices made from eating apples

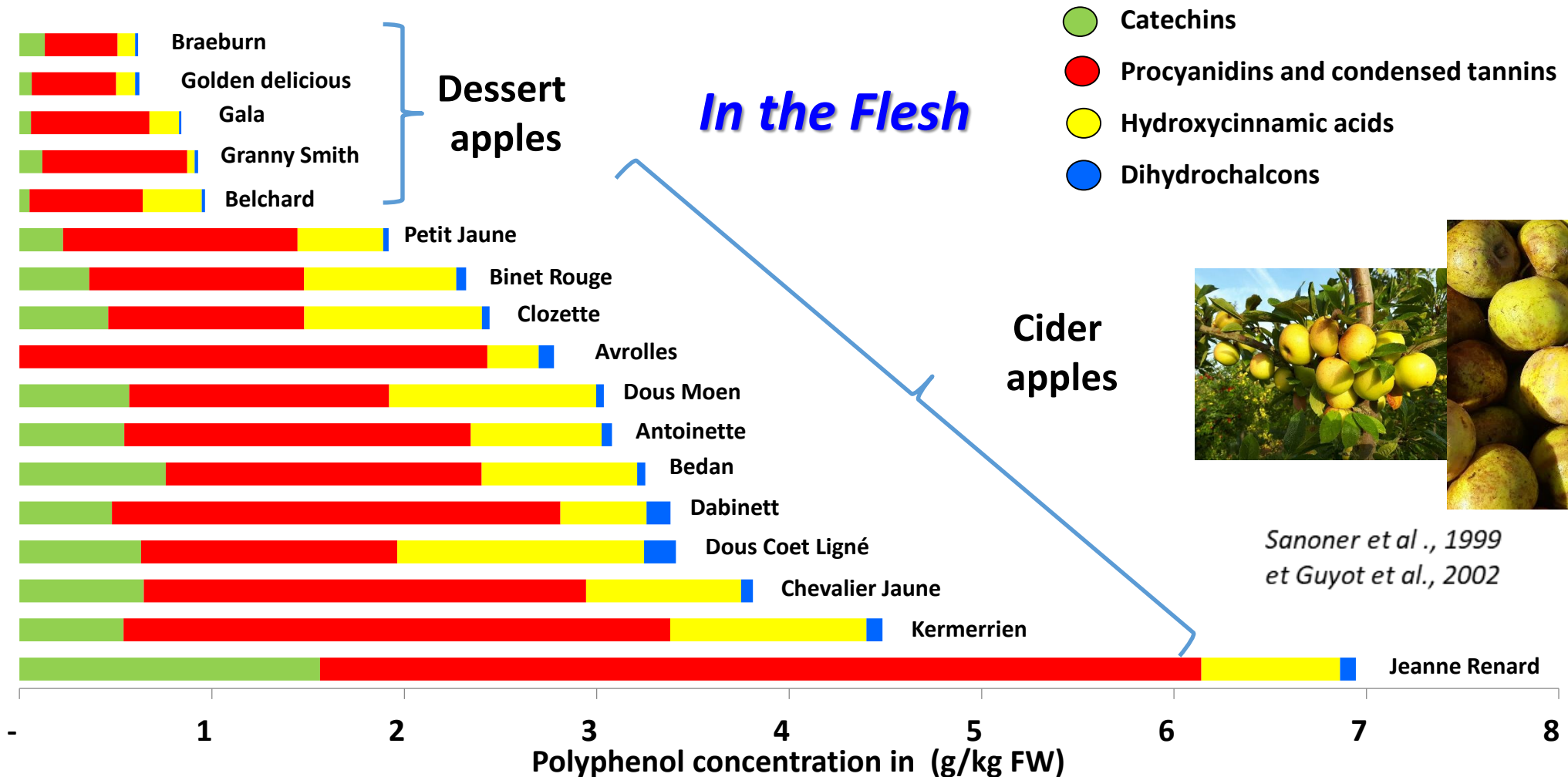
Limiting the during losses during **extraction** of the juice by avoiding oxidation, rapid processing)

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

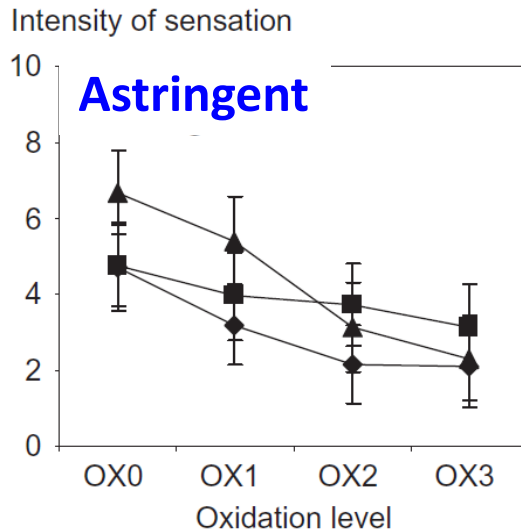
Cider apple clear juices :

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

Sensory analysis

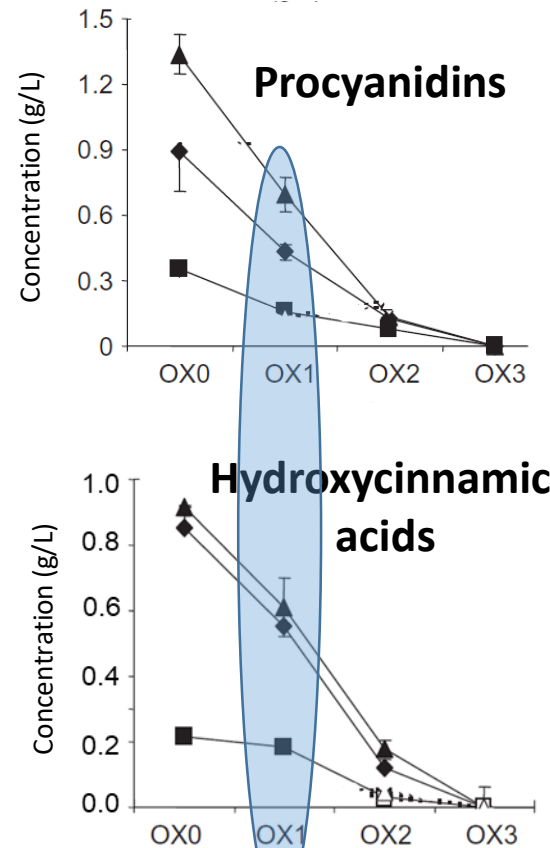
Apple varieties

- ▲ Kermerrien
- Guillevic
- ◆ Dous moen



Decrease of astringency according to oxidation level

Polyphenol assays



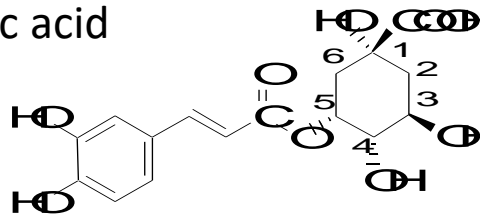
Classical practice in French cider making

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)

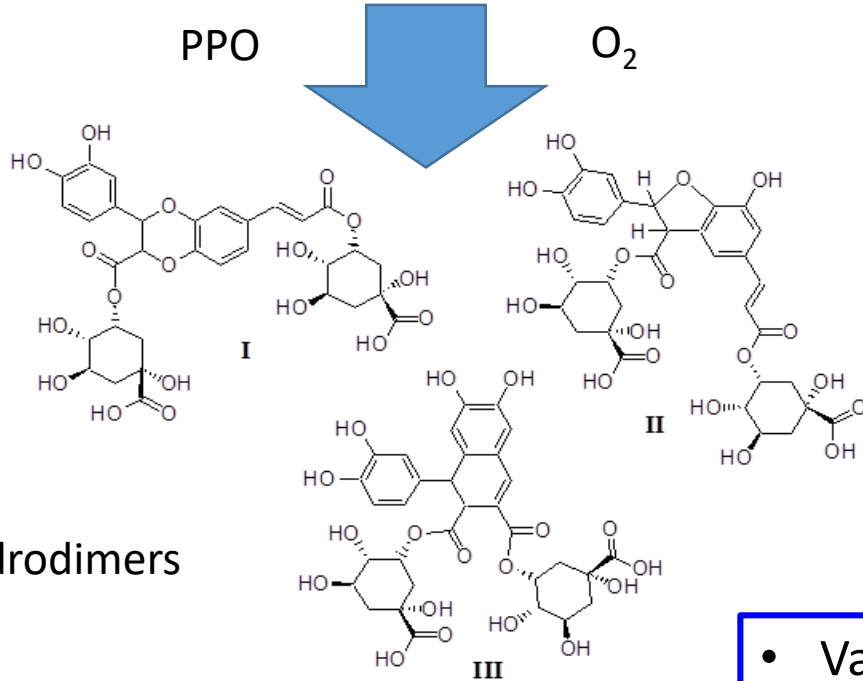
Oxidative conversion of native polyphenols into neoformed oxidation products....the example of chlorogenic acid oxidation products

Chlorogenic acid



PPO

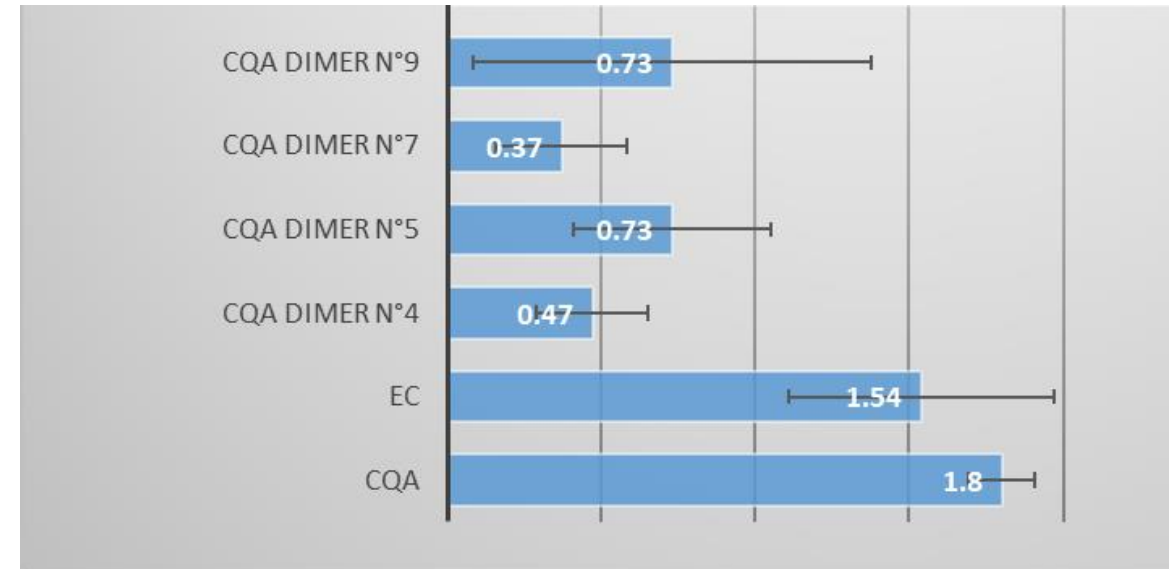
O₂



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

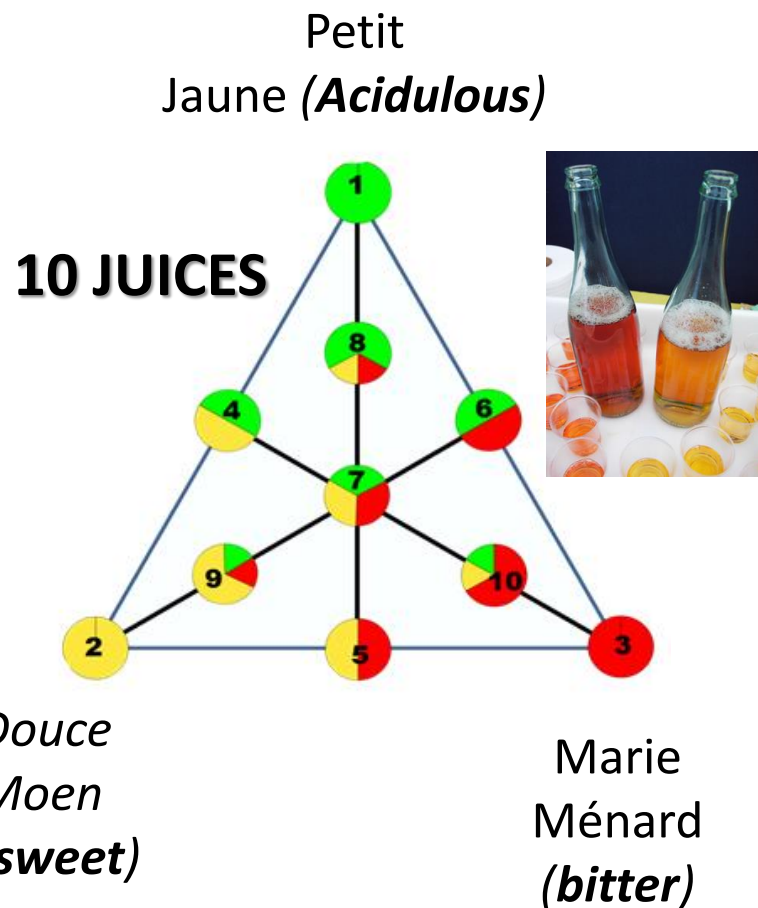
- Various polyphenols structures which still have “in vitro” antioxidant properties
- Several dozens of mg/L in cider apple juices (*unpublished*)



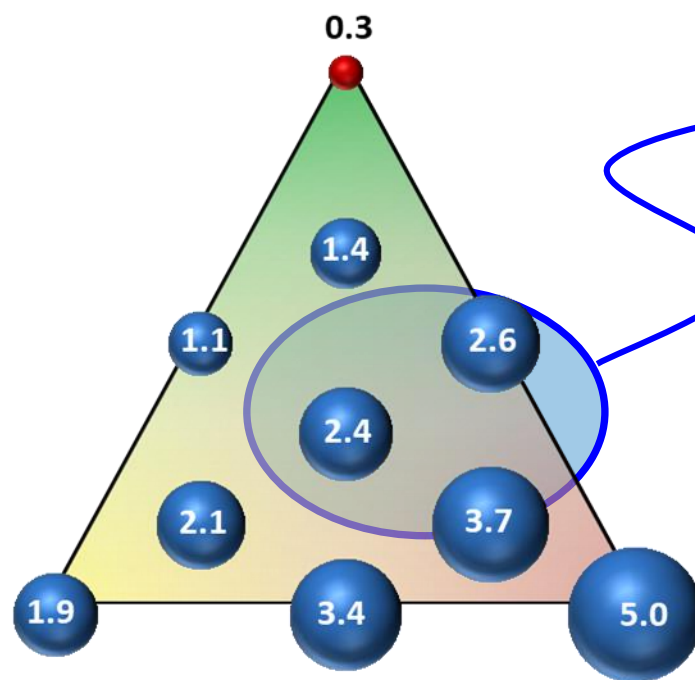
An experimental action of apple juice tasting at International Agricultural Fair (Paris)

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

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

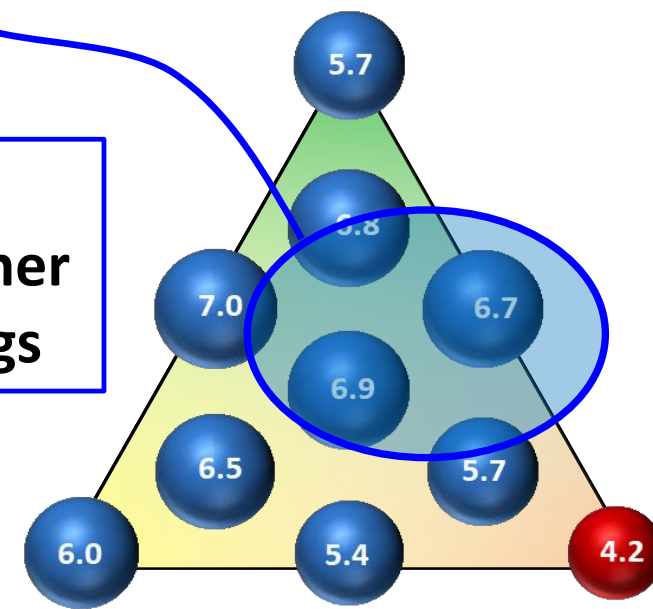


Total polyphenol (g/L)



Appreciation rating (from 0 to 10)

**350
consumer
tastings**



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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