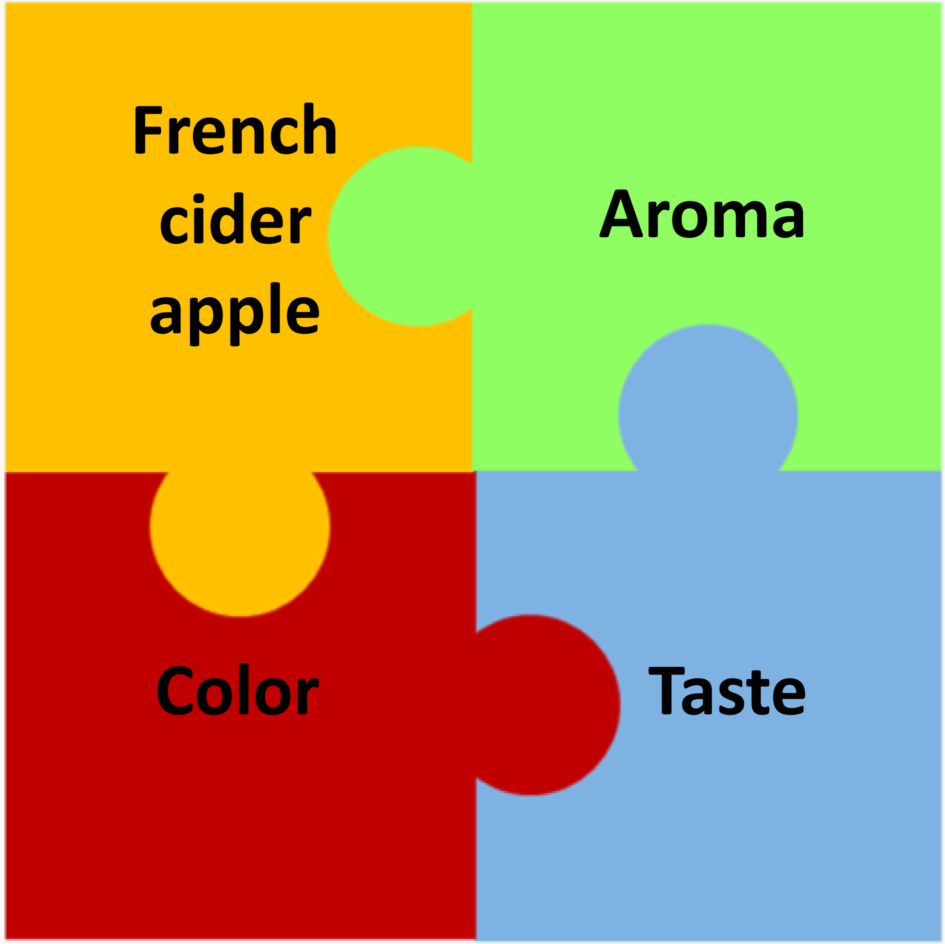
The expression of the apple in its fermented products

Rémi BAUDUIN – IFPC

21/11/2019 3ème Sagardo Forum

Presentation plan



Short overview of IFPC : main figures

Status

Technical Industrial Centre (law 1948)
Qualified by MAAF "Agricultural Technical Institute" et "Agro-Industrial Technical Institute"

Staff

13 employees including 10 permanent people

Budget

1,4 millions €, 40% self-funding (CVE)

Missions

⇨ Elaboration of viable technical references :

- cognitive research with transfer of skills

- experiment programs

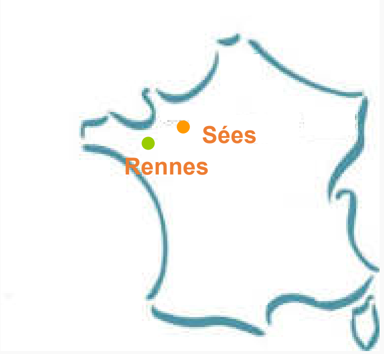
⇨ Coordination of partnership for common programs

Network

RMT (for instance Fermented and distilled beverages), GIS fruits

Chamber of Agriculture, cider makers

Short overview of IFPC : 2 localizations



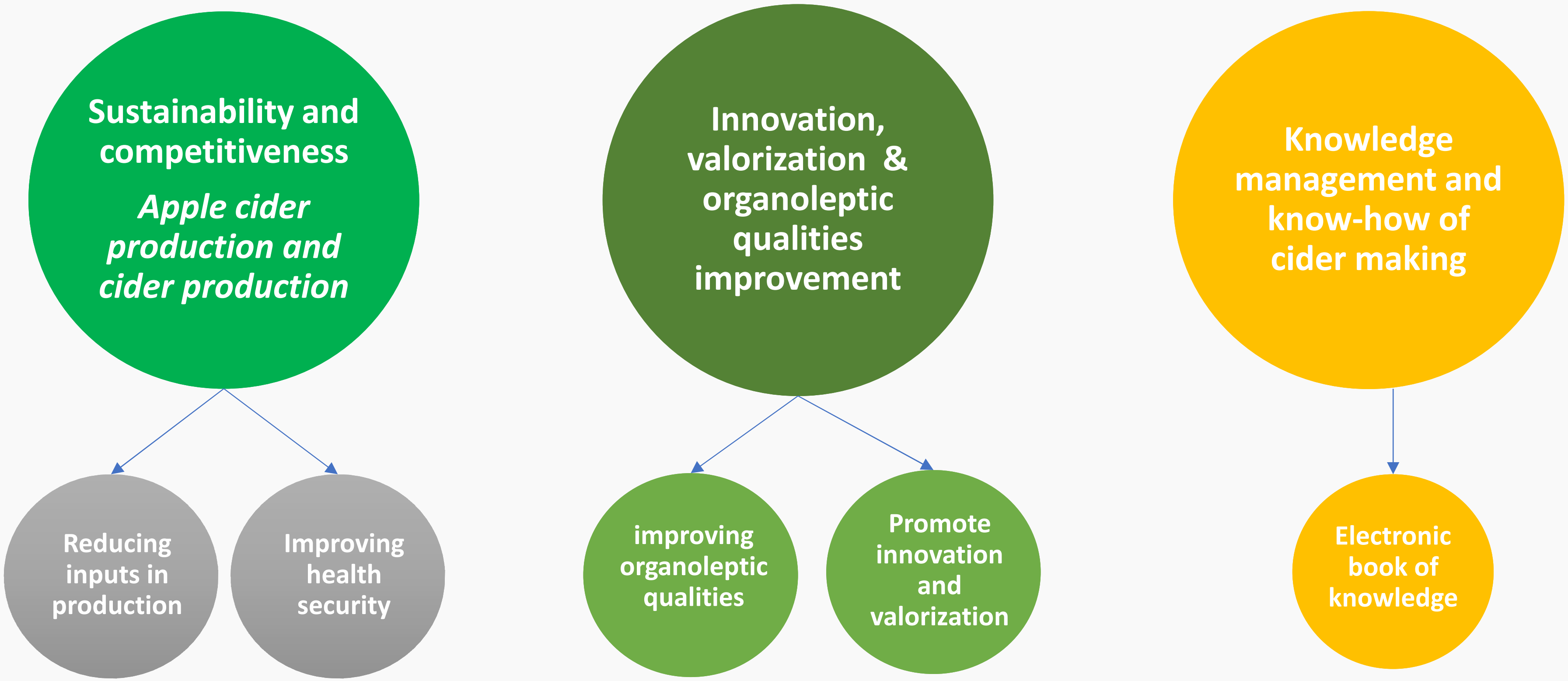
Processing Pilot Plan - Le Rheu (35)

- Located on INRA site
- Surface of 320m²
- Materiel for cider elaboration at a pilot level and with fermentation rooms (100L à 1L)
- 4 thermostatic rooms
- 2 Laboratory for analyses and microbiology
- Analytical plateau shared with INRA (HPLC, LC-MS, GC, GC-MS, GC-MS-MS, GC-MS-O

Station Cidricole - Sées (61)

- 10 ha orchard organized in 1500 to 6000m² units (plots) – trials before producers validation
- An experimental network of 30 production plots
- A greenhouse de 340m² for cider apple species conservation (virus free)
- Laboratory for simple analyses

Short overview of IFPC : main axes



Short overview of IFPC : Partnership

Recherche

Centres techniques et stations expérimentales

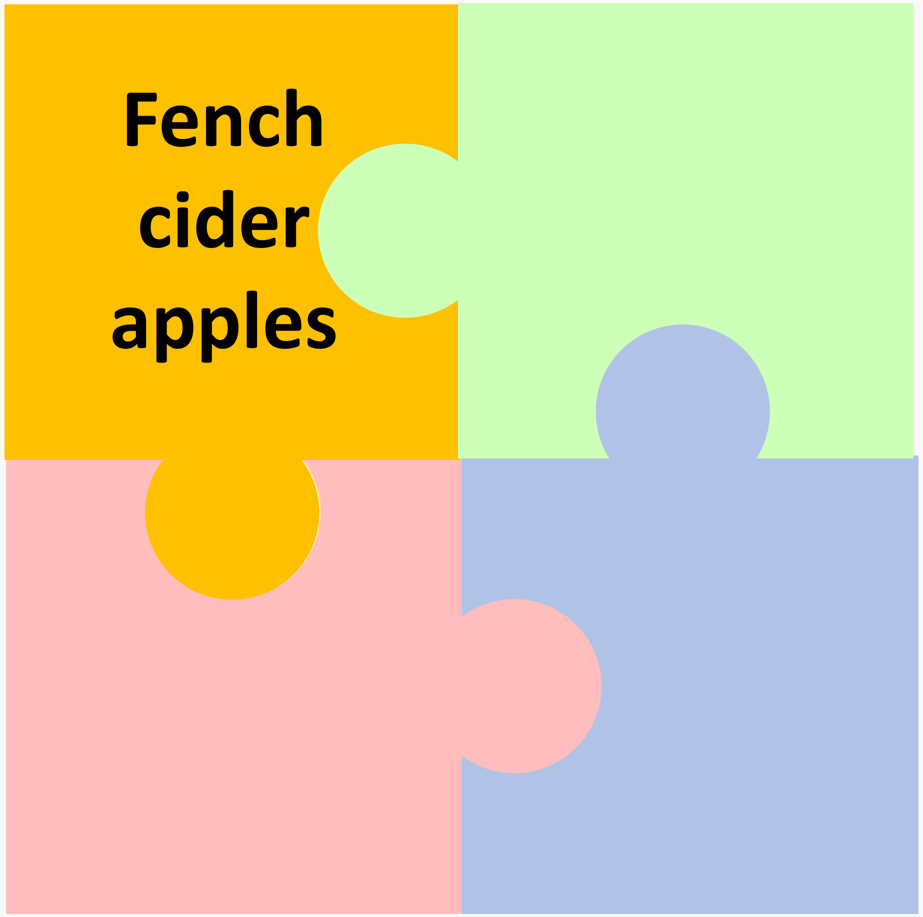
Enseignement supérieur et technique

Développement, associations et syndicats filière

Entreprises

Réseaux

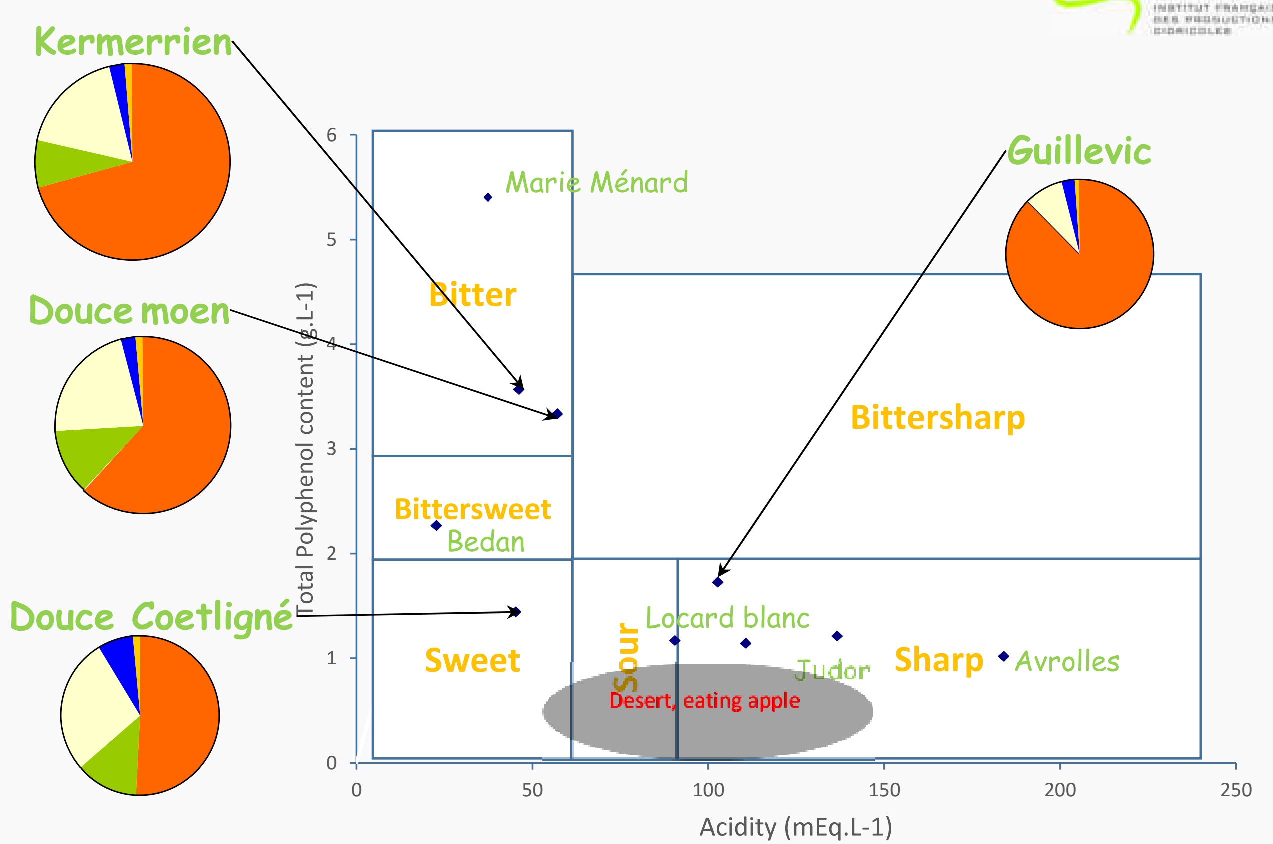
French cider apples



French cider apples

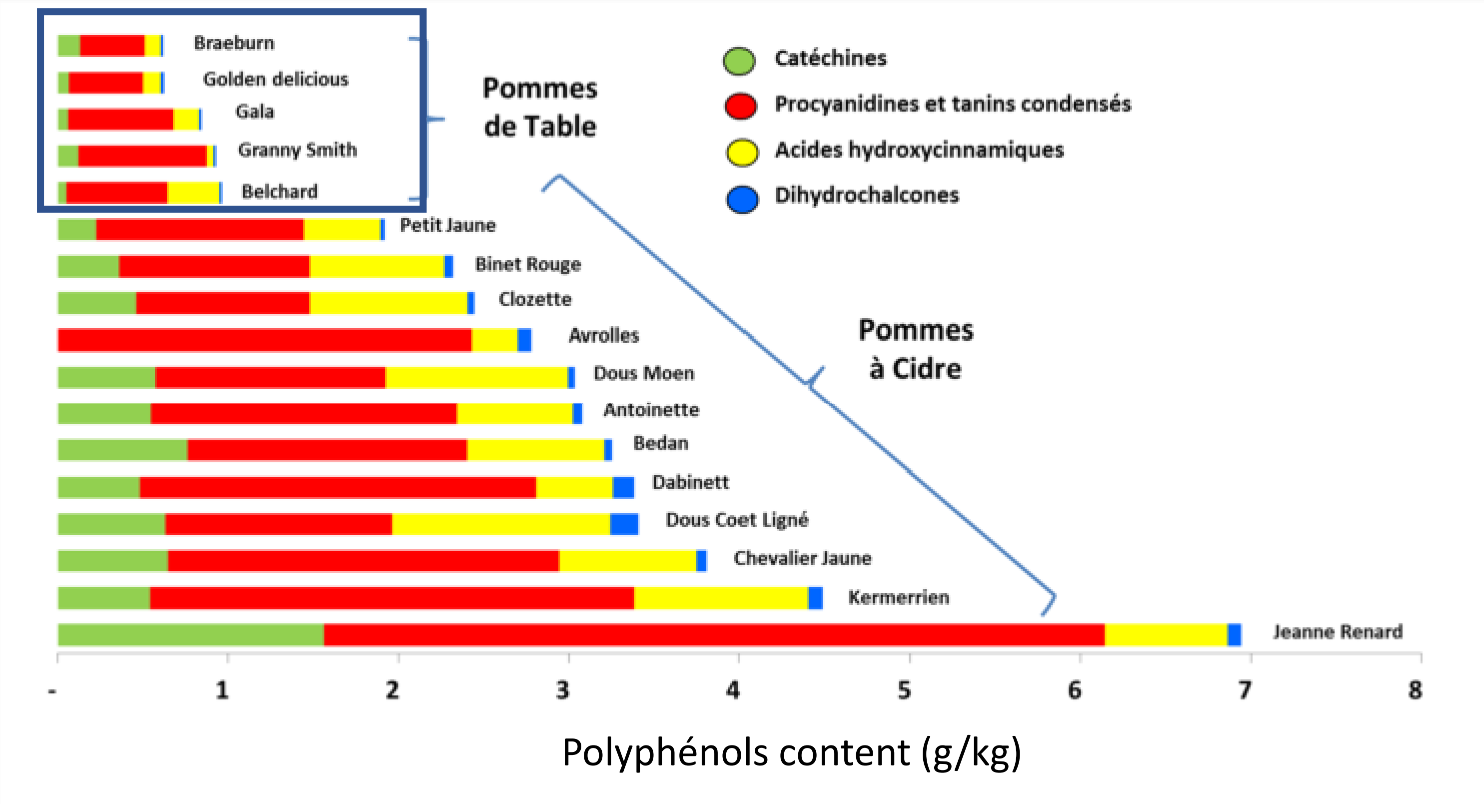
- A pool of cultivar with high polyphenol content :
  - Bitter (3g/L)
  - Bitter sweet (2 to 3 g/L)
  - Sweet (1 to 2 g/L)

- A pool of cultivar with high acidity :
  - Sharp (> 6 g/L H_2SO_4)
  - Sour (3 to 4 g/L H_2SO_4)

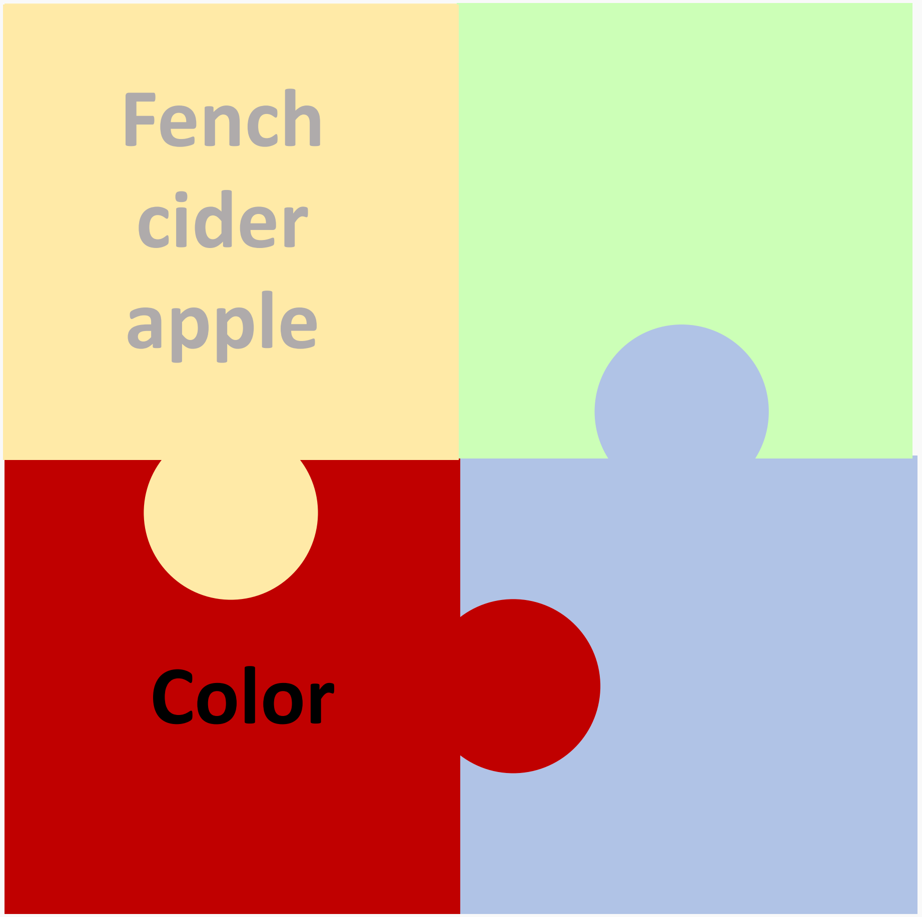


French cider apples

- Comparaison with desert apple



Impact on color



Color impact : polyphenols in apples

- Native polyphenols :

Colorless

Phenolic acids
Procyanidins
Catechin
Dihydrochalcones

Colored

Flavonols

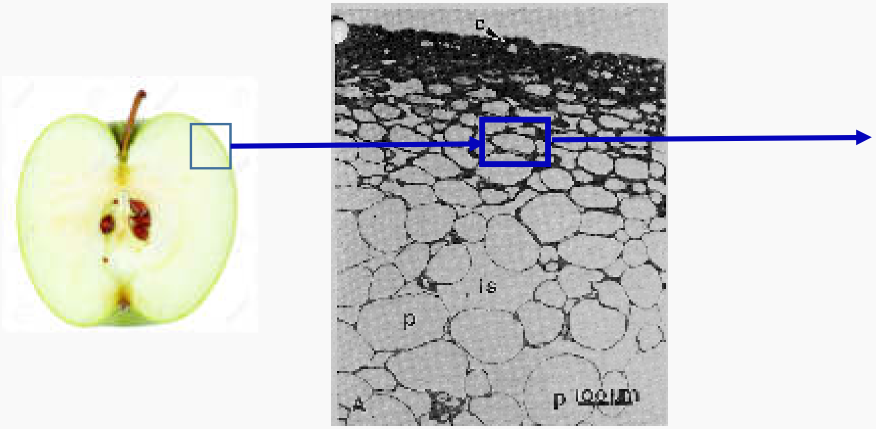
Anthocyanidins

Apple skin

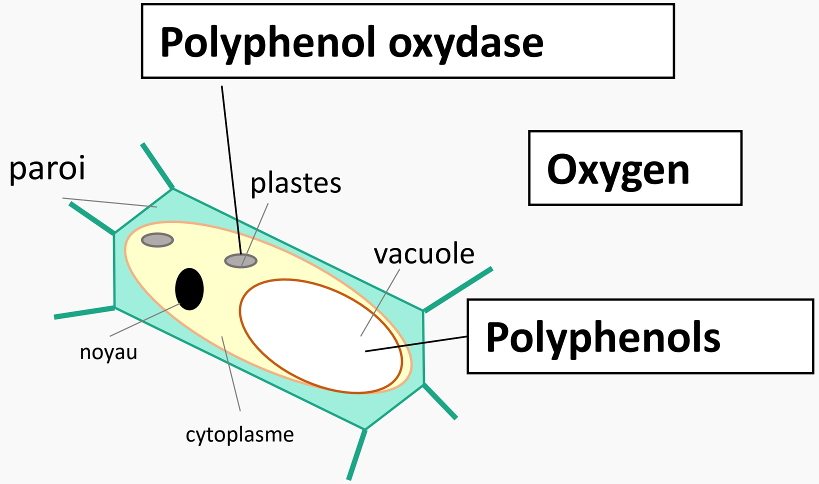
Red flesh Apples

Color impact : oxydation of polyphenols

- In the fruit the 3 components are not in contact … no oxydation

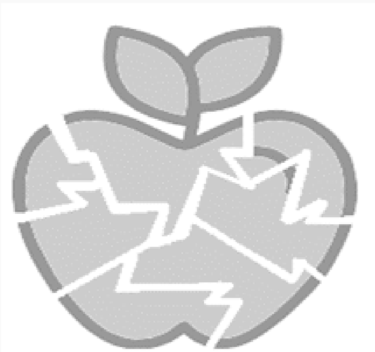


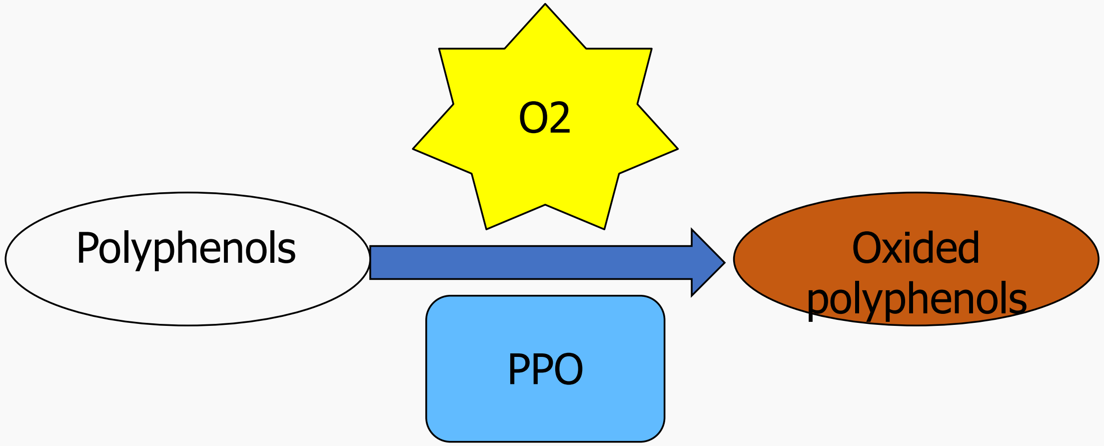
Microscopie tissus de pomme
(extrait de Gregory Glenn and Poovaiah (1987)
Post Harvest Pomology Newsletter, 5(1): 10-19



Color impact : oxydation of polyphenols

- The milling/crushing of apple allows the oxidation of polyphenols



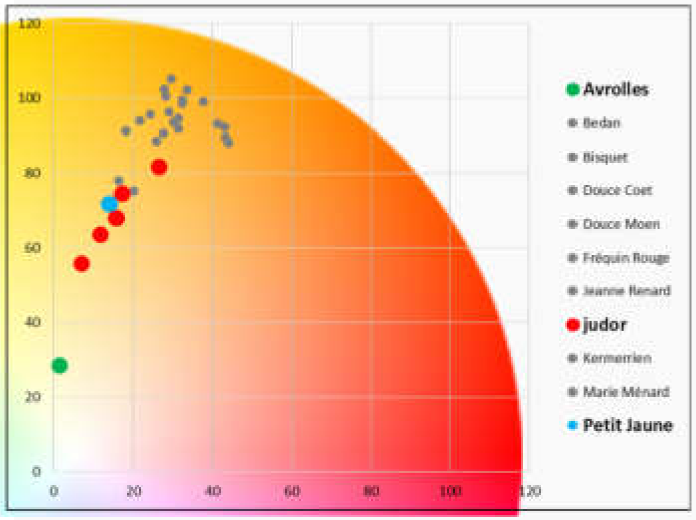


⚠ Coloration of polyphenols is only one of the consequence of their enzymatic oxidation

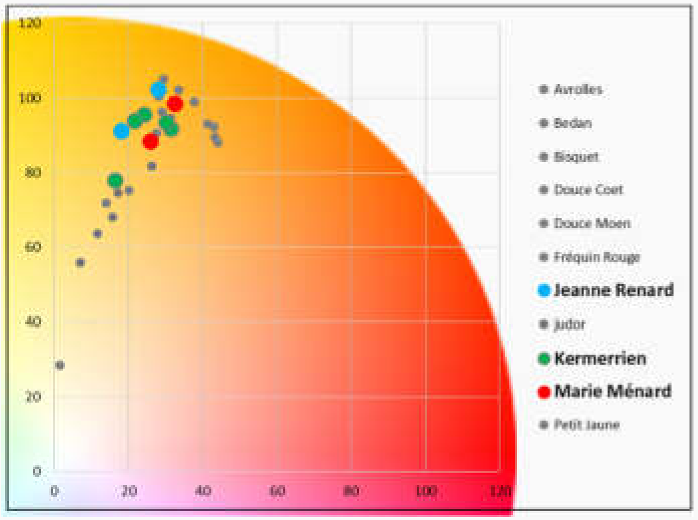
Color impact : varietal potential

- Coloration shift depends of the apple cultivar :
  - Concentration of enzyme (polyphenol oxidase (PPO)),
  - Activity of PPO (pH)
  - Balance between polyphenols chlorogenic acid and polymerized procyanidols

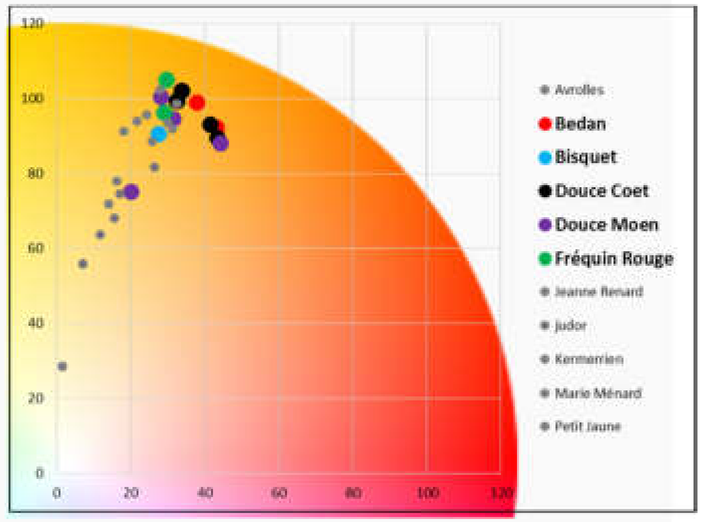
Sharp varieties



Bitter varieties



Bitter-sweet varieties



Color impact : modulation of color shift

- Technology has also a role to play
  - Inerting (CO2 /N2)
  - Oxydation trap (SO_2, ascorbic acid ….)
  - pH decrease and/or thermal denaturation of PPO

Experimentation with *marie-menard* variety

Experimentation on *guillevic* variety

Color impact : case of red flesh apples

- Well suited for « rosé cider » ?

?

Color impact : case of red flesh apples

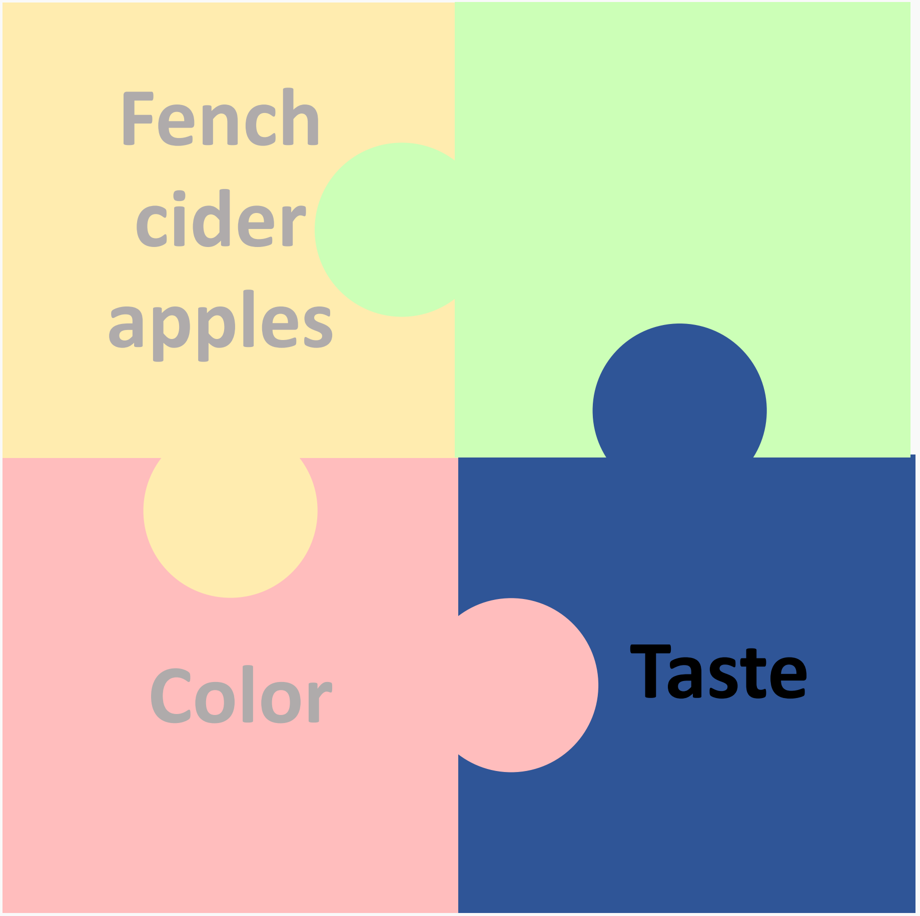
- levers for keeping a red/pink color :

Few anthocyanes
Large amount of PPO and chlorogenic acid
High pH

?

High concentration of anthocyanes
Few amount of PPO and chlorogenic acid
Low pH

Apple impact : Taste



Impact on taste : acidity

- Direct relationship with total acidity

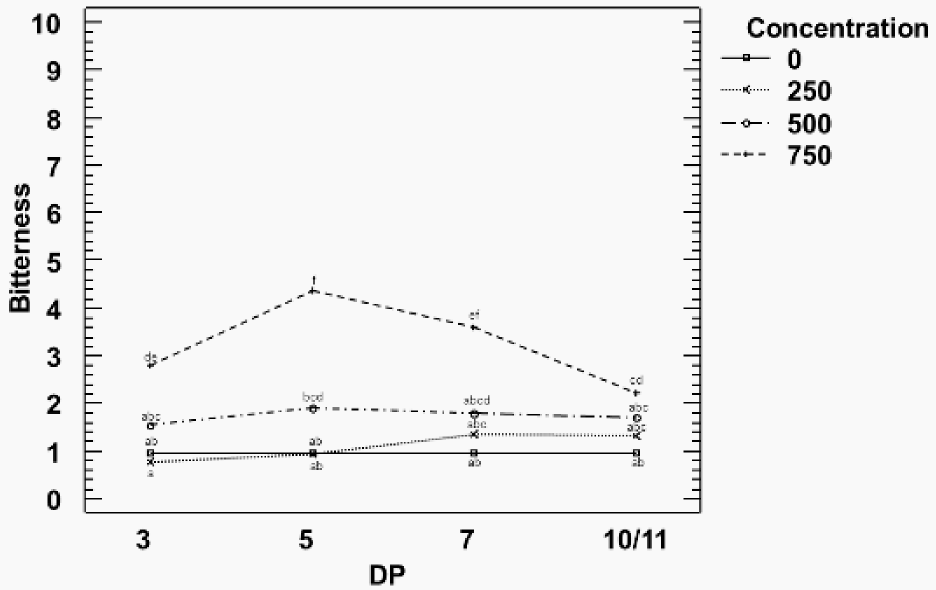
- Large available panel :

  - "Super Sharp" (> 8 g/L H_2SO_4) : Avrolles
  - Sharp (4 to 8 g/L H_2SO_4) : Judor, Petit Jaune, Locart vert
  - Sour (3 to 4 g/L H_2SO_4) : Pomme de Moi, Blanchet
  - Sweet : Bedan, Bisquet, Rouge Duret

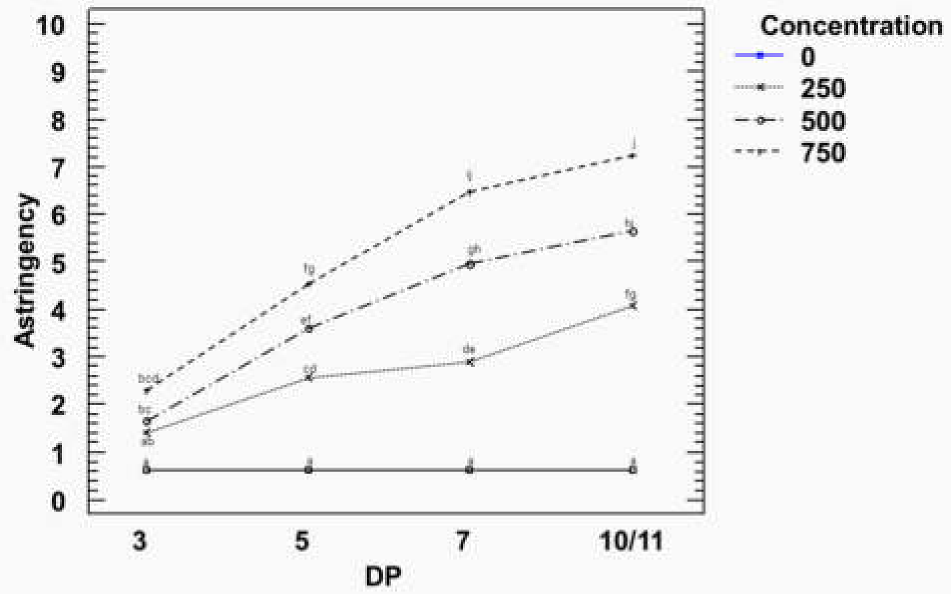
Impact on taste : bitterness and astringency

- Effect of procyanidins concentration and degree of polymerization (DP)

Bitterness



Astringency



- Distribution of DP is different for the apple cultivar

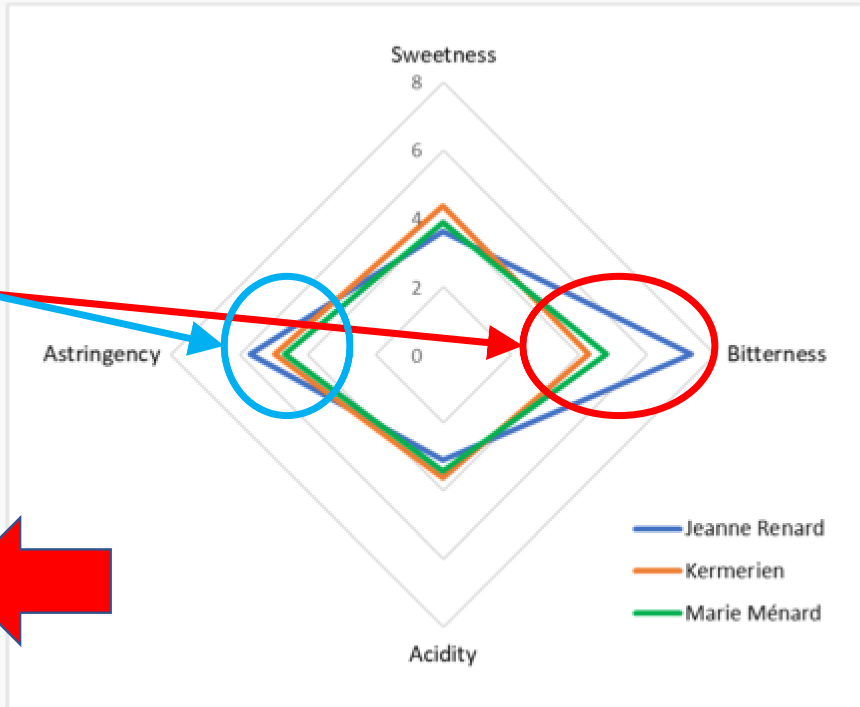
Impact on taste : varietal potential

- Comparison of ciders (monovarietal) made from 3 different bitter cultivars :

Polyphenols analysis

Variety	Polyphenols Folin (g/L)	Avg DP of procyanidols
Jeanne Renard	5,9	4,3
Kermerrien	3,7	5,7
Marie Menard	3,2	4,8

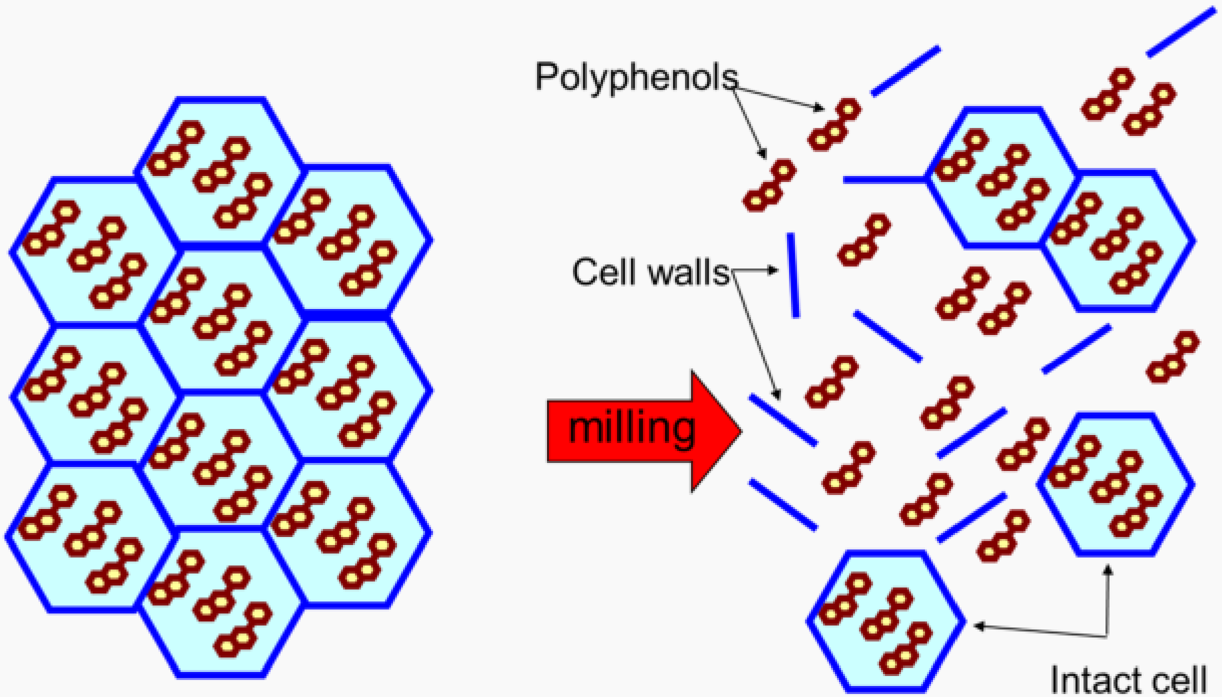
Sensory analysis



For the same level of bitterness (normalization) "Jeanne Renard" add the lowest amount of astringency

Impact on taste : modulation of astringency

- Technology has also a role to play : oxidation of procyanidins and retention on pulp



Impact on taste : modulation of astringency

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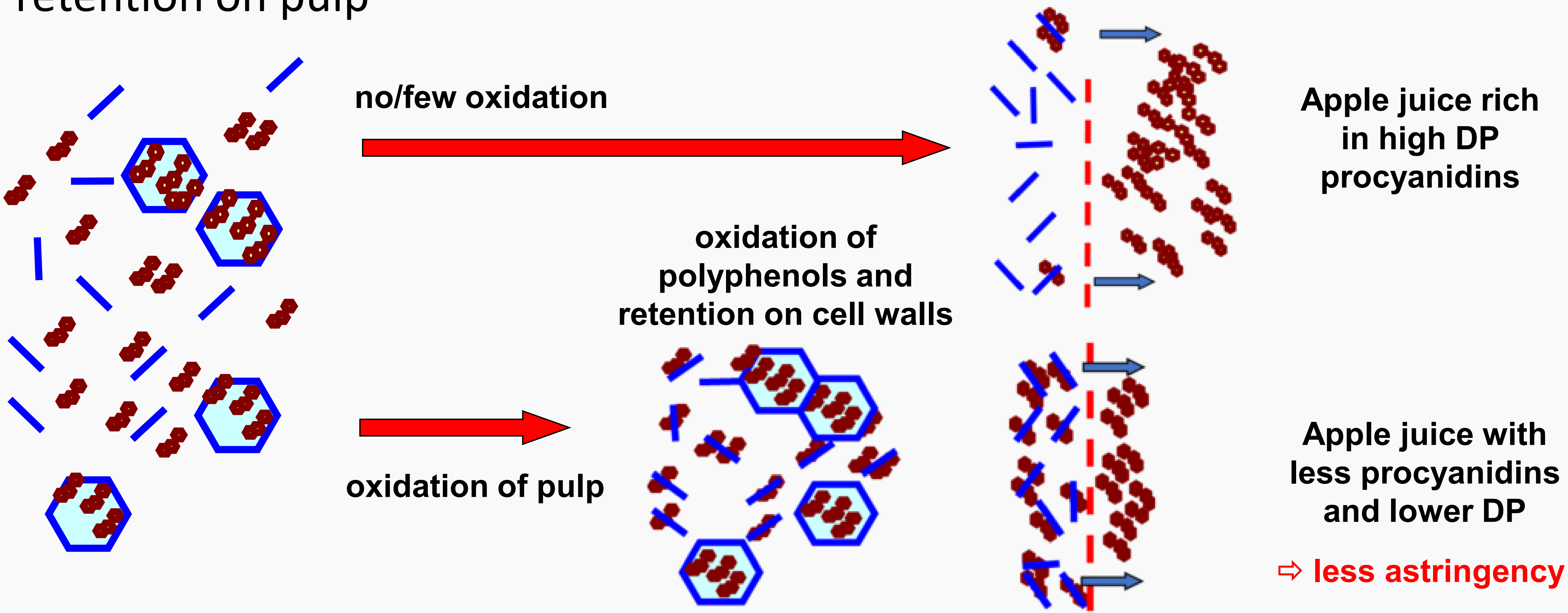
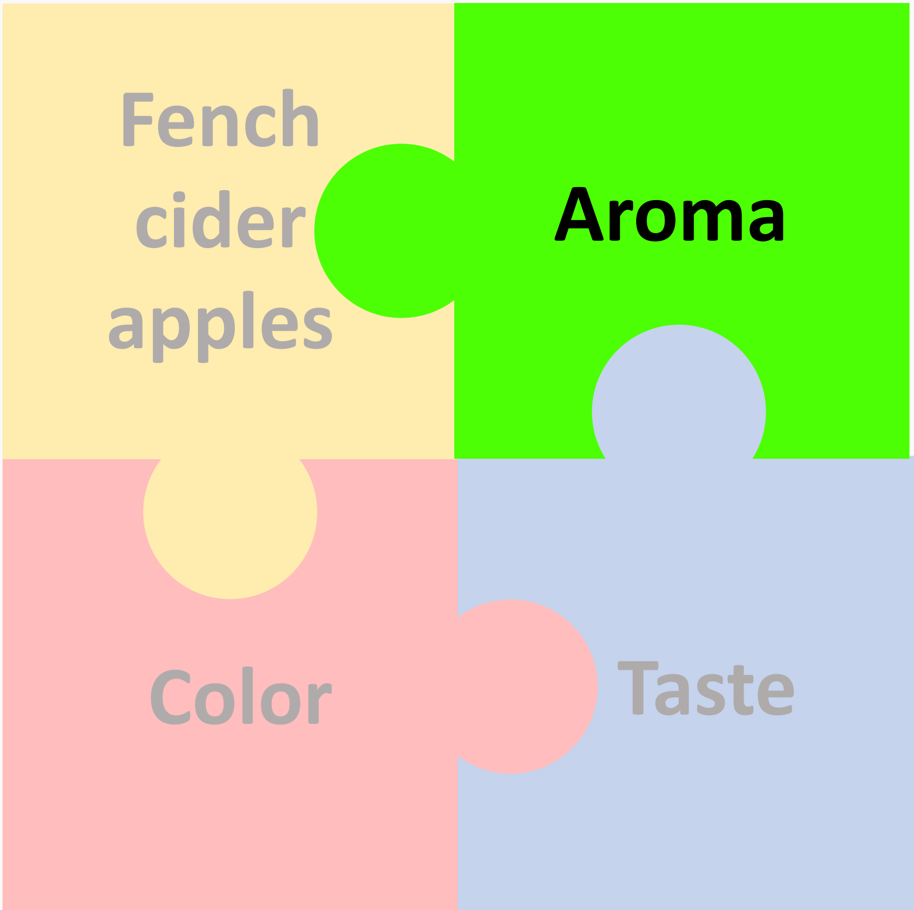


Impact on taste : effets of macroconstituents

- Direct effects and interactions :

	SWEETNESS	ACIDITY	BITTERNESS	ASTRING.
Sugar	+ + +	−	− −	−
Malic Acid	−	+ + +	-	+ +
Polyph DP			DP4 - DP5 + +	DP2 < DP4 < DP6 < DP8
[Polyph]	− −	+	+ + +	+ + +

Aromatic impact

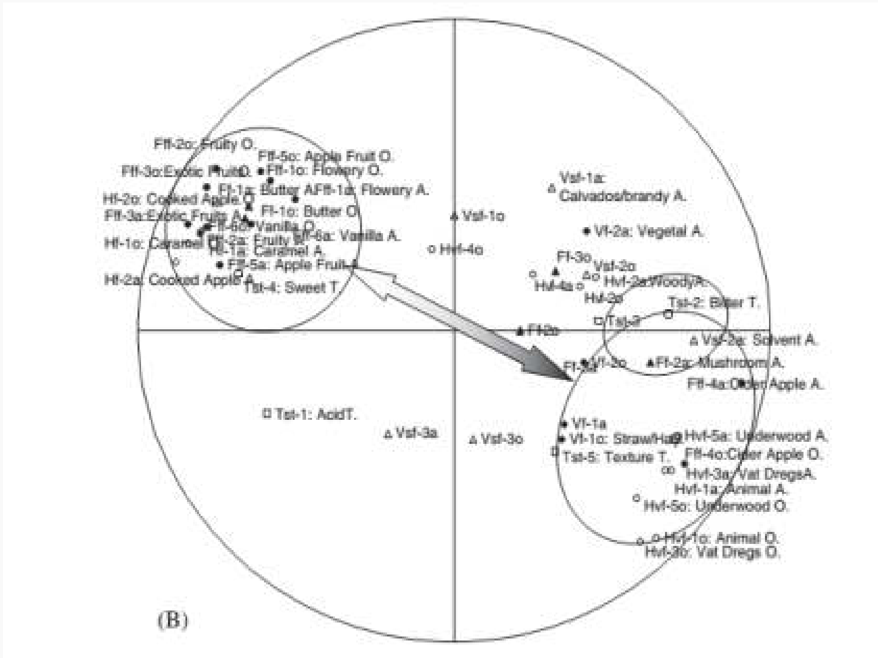


Aromatic impact : introduction

- Bipolar, dichotomous Distribution of French Ciders

Pasteurised
Few Polyphenols
Sweet; Slightly acids

Fruity
Cooked Apple



Le Quéré et al (2006). LWT - Food Science and Technology, 39, 1033-1044

Non Pasteurised
Rich in Polyphenols
Hard Ciders

Animal-like Aromas
Evolved Aromas

Aromatic impact : introduction

- Bipolar, dichotomous Distribution of French Ciders

Pasteurised
Few Polyphenols
Sweet; Slightly acids

Fruity
Cooked Apple

Acetic acid Esters (Acetate)
Ethylic Esters
Phenyl ethanol

Le Quéré et al (2006). LWT - Food Science and Technology, 39, 1033-1044

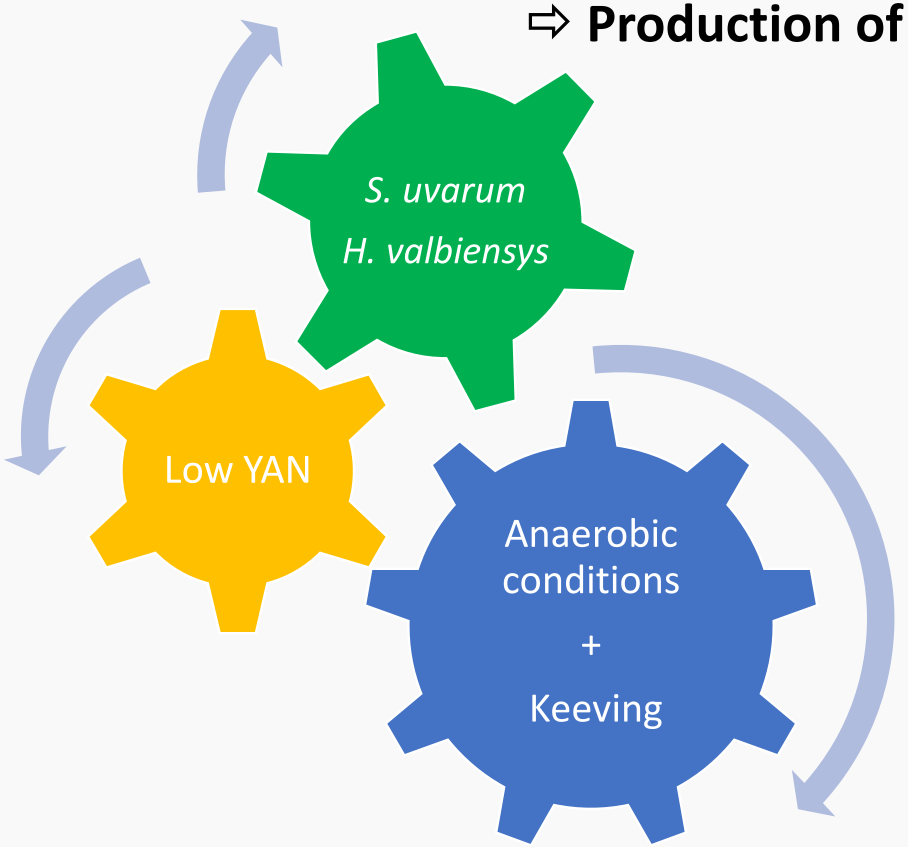
Non Pasteurised
Rich in Polyphenols
Hard Ciders

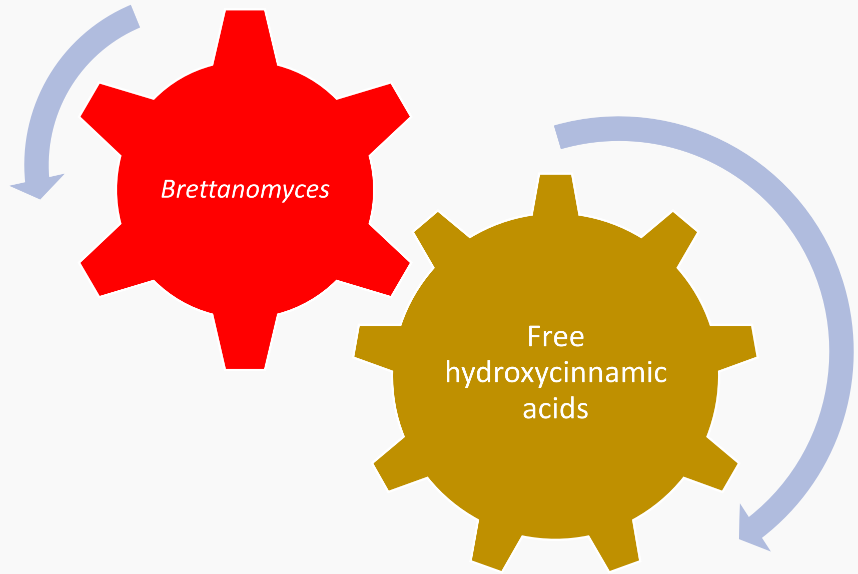
Animal-like Aromas
Evolved Aromas

H2S
Volatile phenols

Aromatic impact : volatiles from fermentation

⇨ **Production of phenyl ethanol & phenylethyl acetate**





⇨ **Production of volatile phenols**

Aromatic impact : work on progress !!

- Hard to find a strong link with varieties
  - Blend of varieties
  - Fermentation with native flora

- Work on progress : volatile compounds from the fruit :
  - Precursors of varietal thiols (some varieties have high concentrations)
  - Terpenes

In conclusion

- Strong organoleptic impact of French apple varieties …

  … mainly related to the polyphenols !

- But ….
  - technology and microbiology could also play a significant role
  - climate and orchard cultural practices

Thanks for your Attention

UMT Nova²Cidre (IFPC & INRA BIA PRP)