Human saliva, taste and food perception

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INRA: French National Institute for Agricultural Research

19 regional centres
8500 permanent positions
1900 PhD students per year

Research fields

- Plant, animal and food sciences
- Agro-ecology
- Human nutrition
- Social sciences
- ...
To better understand physico-chemical, molecular, cellular, behavioural and psychological factors influencing food perception

Humans
Animal models: Drosophila, Rodents

9 research teams
146 permanent staff – 35 PhD students
FOOD PERCEPTION

INTERNAL / EXTERNAL SIGNALS
Hormones
Development and experience
Cultural environment

BIOLOGICAL PROCESSES
Oral cavity / nose
Brain

FOOD CHARACTERISTICS

Team 1
Team 1: In-mouth food processing and flavour perception

Interaction of flavour compounds with food matrix

Mastication and flavour release or perception

Saliva and taste (3 researchers)
Whole saliva: a complex fluid

Composition: water, ions, nucleic acids, lipids…
proteins / peptides (over 1000 described)
Saliva proteins and taste

Saliva / tastant interaction → depolarisation → signal processing → taste perception

Mouth → Taste bud TRCs → brain

Saliva proteins

acceptance
- **Histatin / quinine.** Histatin 5 concentration significantly lower in subjects hypersensitive to quinine. *Wada et al., 2010.*
Saliva proteins and taste acuity – CA6


*Padiglia et al., 2010.* PROP taster status associated with CA6 polymorphism at the active zinc binding site.
Two main research objectives

Are the salivary profiles stable / variable?
- with developmental stage in infants
- with time (day, year)
- in response to taste stimulation or diet

May the saliva composition predict taste sensitivity or taste acceptance?
Variation of protein profiles with age during infancy

A longitudinal study on 3 and 6 month-old infants (n=73).
Saliva proteins separated by 1-D electrophoresis

Quantification in arbitrary units

Profiles are modified substantially: 13 out of 21 bands vary in abundance between 3 and 6 months of age.

Increase of amylase abundance and activity

Abundance of amylase bands (n=73) amylase activity (n=42)

Circadian variations in salivary profiles

12 subjects, at-rest saliva sampled AM / PM of the same day.

Saliva proteins separated by 2-D electrophoresis

one spot ~ one protein: quantification in ppm
Circadian variations in salivary profiles

Overall, limited circadian effect

A very high between-subject variability

Out of 509 spots detected, 47 differ significantly between subjects.

Modification of saliva proteome by taste stimulation

Comparison of saliva profiles after stimulation (15 sec) by four taste solutions

Profiles are altered differently
acid > bitter > umami > sweet

An inflammatory-like response to bitterness

Modification of saliva proteome by bitter tastants

Comparison of saliva profiles 15 minutes after ingestion of two bitter tastants: urea and quinine

Profiles are altered and the response is molecule-specific

Impact of diet transition on infants’ saliva

duration of exposure to **solid foods**

- Positive correlation with abundance of S-type cystatins
- Positive correlation with abundance of β-2 Microglobulin

**Inhibition of dietary cysteine proteases**

Conclusions (1): saliva variability / stability

**Infancy** is a period during which salivary profiles are still evolving. Childhood?

Once settled, **in adults**, profiles are extremely variable from one subject to the next, but relatively stable (circadian and seasonal variations) within the same subject: **biological signature**.
May the saliva composition affect taste sensitivity or taste acceptance?

**Fat perception** and fat liking in adults

Sensitivity to the **bitter taste of caffeine** in adults

**Taste acceptance** in infants
Fat perception / fat liking

13 adults tasting an oil-in-water emulsion

fat intensity
fat liking
at-rest saliva characteristics

Correlation of data by PCA

Sensitivity to bitterness: sensory aspects

29 male healthy subjects. Detection threshold for the bitter taste of caffeine.

Differences of **protein 2D profiles** between subjects hyposensitive / hypersensitive to caffeine.

**Hypersensitive subjects:**

+ fragments (amylase, serum albumin)

– cystatin SN

Sensitivity to bitterness: cystatin expression

Sensitivity to bitterness: in-mouth proteolysis?

Hypersensitive subjects

Less protease inhibitors

More fragments of the salivary film constituents

A thinner or looser salivary film: facilitated interaction between caffeine molecules and TRCs

Taste acceptance in infants (n=73)

\[
\text{intake ratio} = \frac{\text{vol2 + vol3}}{\text{vol1 + vol2 + vol3 + vol4}}
\]
Salivary profiles

21 bands detected in at least half of the children
Salivary profiles / intake ratios

**Multivariate statistical analysis (PLS):** relative quantities of bands vs intake ratios. Crossed validation.

At 6 months, no statistical link between salivary profiles and taste acceptance.

At 3 months, **bitterness** stands out.
Markers of bitterness acceptance

Infants who accept bitterness have higher proportions of S-type cystatins (band 15)

Infants who reject bitterness have higher proportions of band 9 (containing CA6)
Conclusions (2): saliva and taste

Taste perception does not depend only on genetic variability of taste receptors!

Saliva is probably an important peri-receptor factor conditioning in part the way we perceive and appreciate the taste of food.
Thank you for your kind attention