Formulation with F ava bean (Vicia faba L.) or Fava bean + Flaxseed delayed lipid oxidation in frankfurter and during its digestion

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Background & objective

The sustainability of meat consumption is the subject of much debate, for reasons of ecological footprint. Plant-based ingredients, especially from legumes or seeds can participate to partial replacement of animal protein especially if it adds value. Rich in proteins, fava beans are a good candidate, provided they are obtained using a process that reduces anti-nutritional factors. Moreover, this crop contains vitamin, mineral, dietary fibre, phenols and flavonoids. Flaxseed, an oil-seeds, is well known for its richness in alpha-linolenic acid and is considered as a great source of ω-3 polyunsaturated fatty acids. But, its alphalinolenic acid content is highly susceptible to oxidation.

Therefore, we aimed to evaluate the benefice of partial replacement of meat protein by fava bean and flaxseed flour on the nutritional quality of frankfurter.

Materials and Methods

1. Frankfurter making

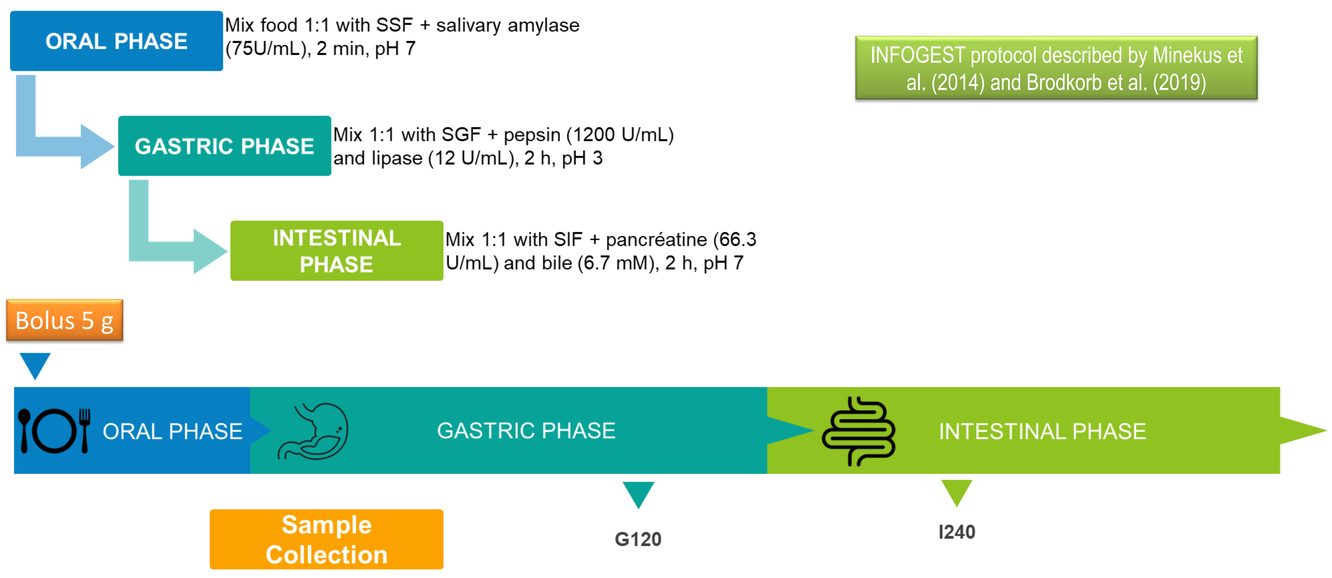
Legume powder enrichment 4 % w/w
Legume flours : Fava bean FB & Fava bean + Flaxseed FBFS

2. Frankfurter composition analysis

3. Bolus formation *: in vivo* mastication tool

Granulometry control (sieves) : particle size consistent with *in vivo* data

4. *In vitro* adult digestion



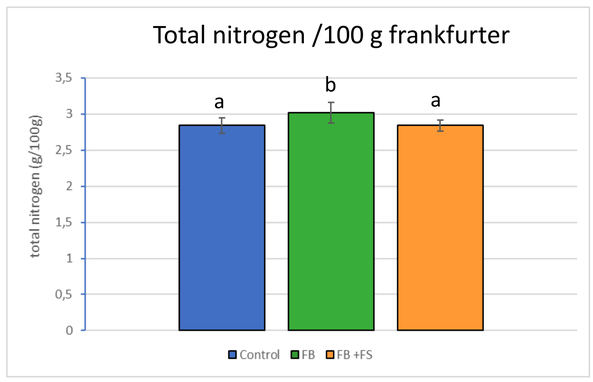
Digestates sample collected at 120 min the gastric compartment and at 240 min in the ileal compartment

Biochemical characterization of frankfurters : Textural properties TPA, lipid content, composition and oxidation (D1 – D6), nitrogen content (Kjeldhal)
Microstructure characterization of frankfurters : Sections of 10 µm thick, stained with red oil for fat droplets and Sirius red for collagen. Micrographs acquired at 20x magnification using an Olympus BX 61 microscope equipped with a high-resolution digital camera (Olympus DP 71) and an Olympus Cell Sens software.
Biochemical characterization of digestates : nitrogen fractionation, lipid oxidation,

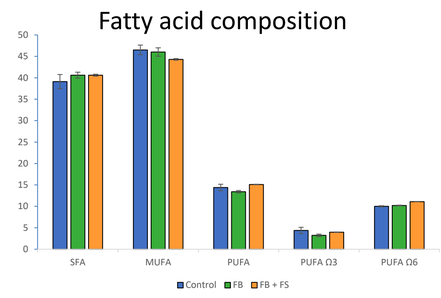
Statistical analysis : ANOVA and Tukey *post-hoc* tests were performed on variables from products & digestates with Jamovi software

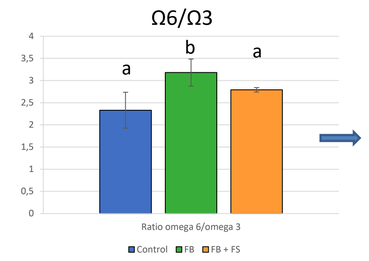
Results

Composition



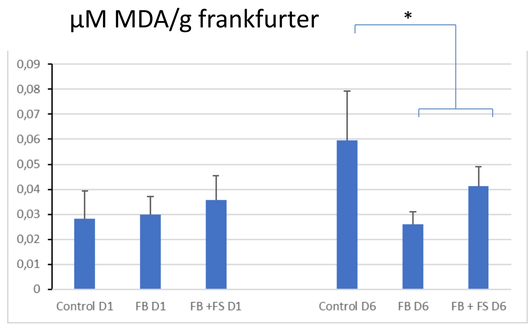
→ Higher amount of proteins with FB





Fatty acid composition similar but frankfurter formulated with FB has higher Ω 6 / Ω 3 ratio

Lipid oxidation during storage (Day 1 – Day 6)



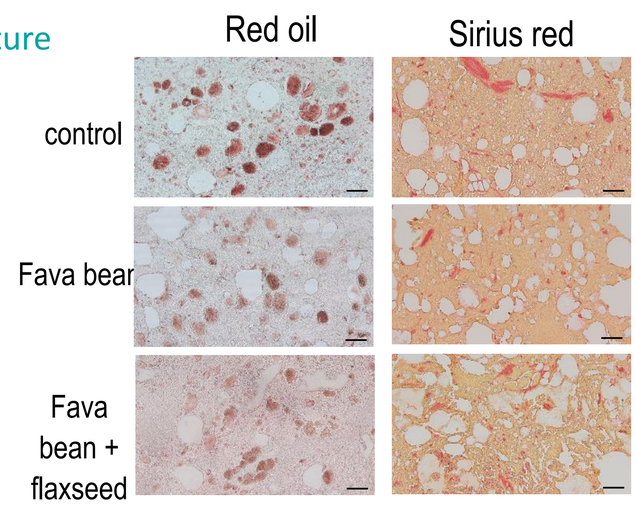
→ Less oxidation in Frankfurter during storage with FB or FB + FS

Textural properties TPA

formulation	Firmness	Cohesiveness	Elasticity	Gumminess	Adhesivenes s
control	103 +/- 10 [a]	0.43 +/- 0.03	0.78 +/- 0.6	45 +/- 7 [a]	0.14 +/- 0.05 [a]
FB	97 +/- 11 [a]	0.42 +/- 0.05	0.76 +/- 0.05	41 +/- 8 [a]	0.13 +/- 0.01 [a]
FB FS	44 +/- 3 [b]	0.40 +/- 0.06	0.79 +/- 0.09	18 +/- 4 [b]	0.05 +/- 0.01 [c]
P value	0.001	NS	NS	0.001	0.001

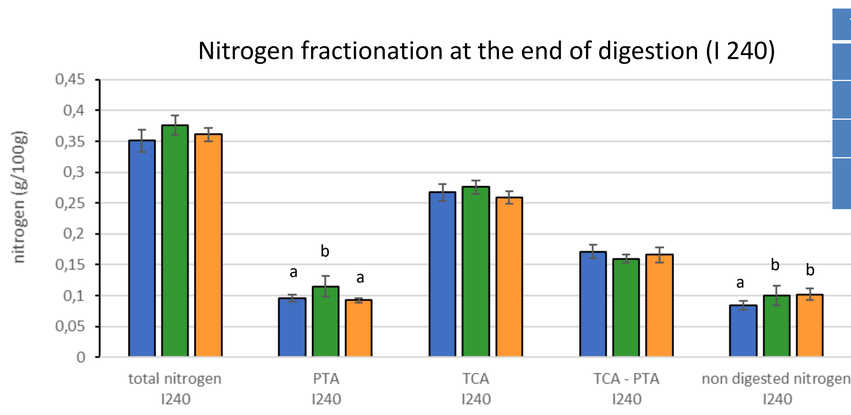
→ Addition of FB + FS in Frankfurter modifies the textural properties, ie firmness and the gumminess, which is interesting for people suffering chewing disability

Microstructure



→ Smaller lipid droplets in Frankfurter formulated with FB and FB + FS

Digestion



formulation	MDA µM
control	34.3 +/- 2.8 [a]
FB	24.4 +/- 1.4 [b]
FB FS	28.6 +/- 2.7 [c]
P value	0.001

→ A higher quantity of small peptides found with FB frankfurter, which indicates greater digestibility. In addition, less oxidation recorded with frankfurters formulated with FB and FBFS.

Conclusions

- ❑ Reducing our animal protein intake can be achieved by developing mixed animal and vegetable protein products to reduce our carbon footprint.
- ❑ Moreover the digestibility of frankfurters was not negatively affected by plant pulses flour, which can be explained by the extrusion process, which reduces or even annihilates anti-nutritional factors.
- ❑ The deficiency in sulphur amino acids in pulses is counterbalanced by those provided by meat.

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