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Effects of protein source and cooking procedure on intestinal microbiota and on fermentation end-products in rats

C. Poelaert[1,2], X. Despret[1], D. Portetelle[2], M. Sindic[3], G. Eppe[4], B. Taminiau[5], G. Daube[5], C. Nezer[6], Y. Beckers[1], A. Théwis[1] and J. Bindelle[1]

[1]Precision Livestock and Nutrition Unit, [2]Microbiology and Genomics Unit,
[3]Laboratory of Agro-food Quality and Safety, Gembloux Agro-Bio Tech (University of Liège), Belgium
[4]Center for Analytical Research and Technology (CART), Chemistry Department, University of Liège, Belgium
[5]Department of Food Science, FARAH, Faculty of Veterinary Medicine, University of Liège, Belgium
[6]Quality Partner S.A., 4040, Herstal, Belgium

Introduction

Animal and plant proteins are major proteins sources in the human diet. By contrast to plant proteins, animal proteins are under the fire of critics for their possible impact on human health.

Intestinal fermentation of proteins can lead to the production of some potentially harmful meatbolites:

Undigested fraction of dietary proteins —*Microbial fermentation*→ SCFA, NH_3, biogenic amines, sulphur metabolites, phenols, indoles, etc.

Question addressed

Does the nature of the protein source (animal or plant origin) and the cooking procedure (raw or cooked) influence the composition of gut microbiota and on fermentation end-products in a rat model?

Materials and Methods

Animals: 84 weanling male Sprague-Dawley rats

Protein sources:

Beef muscle → Raw; Cooked in a water-bath (60 min; 70°C)

Chicken breast → Raw; Cooked in a water-bath (60 min; 85°C)

White beans → Raw; Vapor-cooked (60 min)

Soybean → Raw; Vapor-cooked (60 min)

Experimental diets:

- 15% crude protein, 5% fat, 5% crude fibre, 5% mineral mixture and vitamin mixture
- Tested animal or plant protein sources = sole source of protein in the diet
- 4 diets with animal proteins and 4 diets with plant proteins
  + *a control diet (containing casein as protein source)*

Experimental design:

- Feeding rats (N=7) their experimental diet for 4 weeks
- Euthanasia and collection of caecal contents

Analyses of the caecal contents:

- Pyrosequencing using Roche 454 GS Junior Genome Sequencer
- Measurement of short-chain fatty acids (SCFA) and branched-chain fatty acids (BCFA) using HPLC (Waters 2690)

Results

Microbial composition of the caecal content

- At phyla level, relative abundance of Firmicutes is increased with plant-based diets compared to control diet, counterbalanced by a reduced abundance of Bacteroidetes.
- For meats-based diets, abundance of Firmicutes is similar to control diet whereas Bacteroidetes is less abundant with diets containing chicken meat, raw or vapor-cooked, compared to control diet.
- Abundance of Firmicutes and of Bacteroidetes is not significantly influenced by the cooking procedure (raw or vapor-cooked).

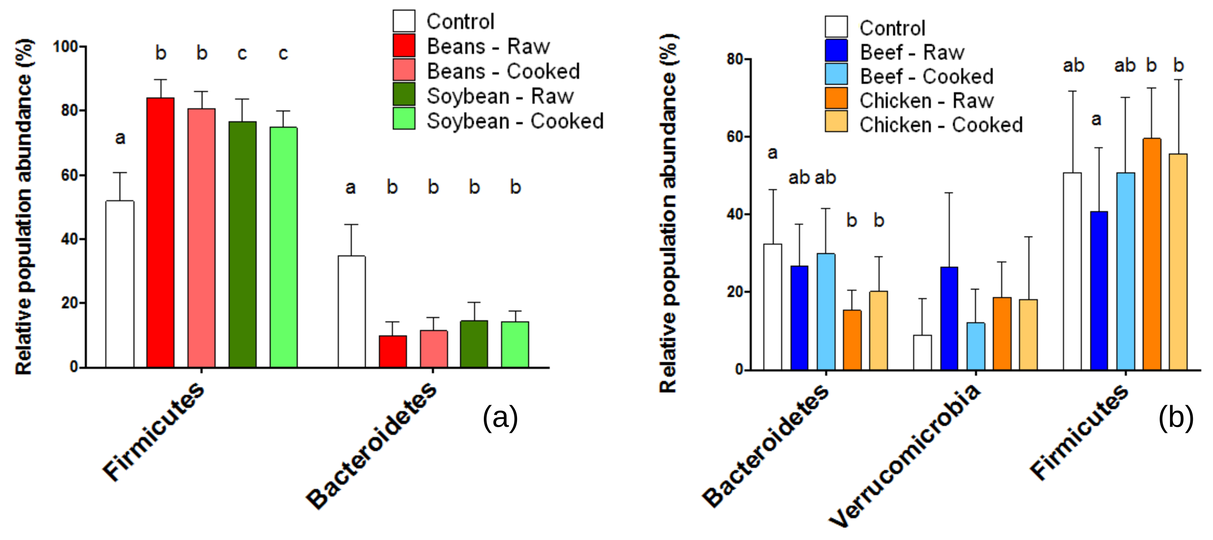

Figure 1. Relative abundance of major phyla in the caecal content of rats receiving an experimental diet containing (a) plant proteins or (b) meats by comparison with control diet.

SCFA and BCFA productions in the caecum

- The SCFA and BCFA productions in the caecum are mainly affected by the protein source (animal or plant origin), less so by the cooking procedure.
- Both animal protein sources display higher proportion of BCFA (mainly isobutyrate) but lower molar ratio of acetate as compared to plant proteins
- BCFA represents 4-6% and 35-44% of total SCFA with diets based on plant and on animal proteins, respectively.

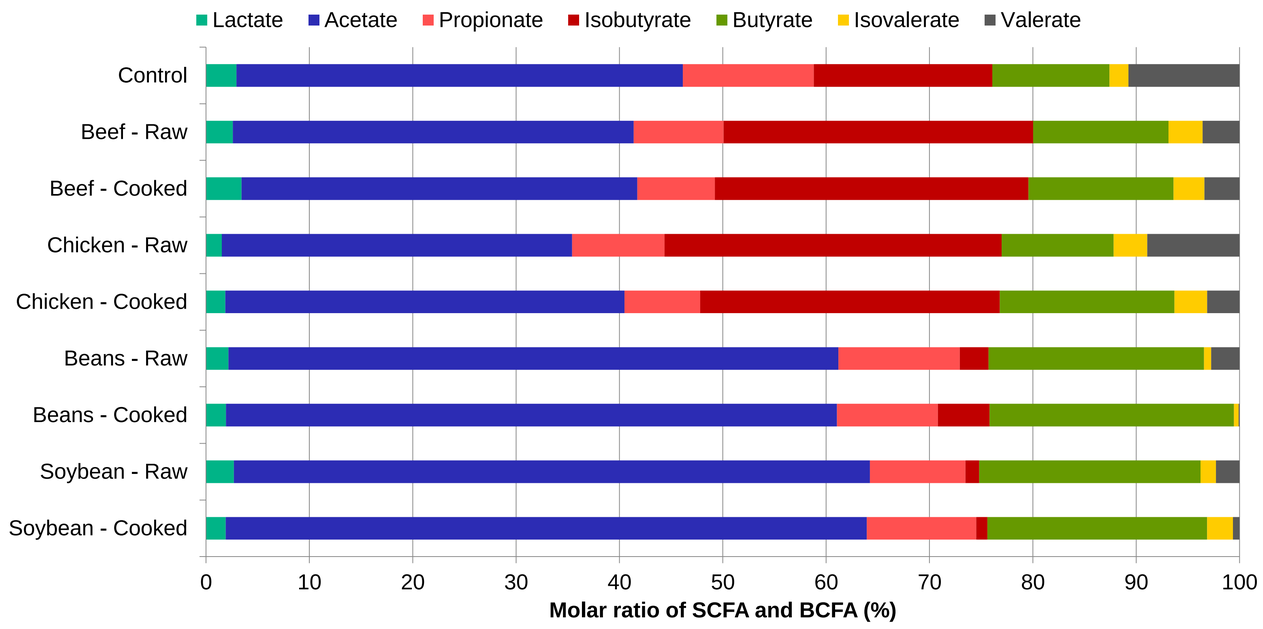

Figure 2. Production of short-chain fatty acids (SCFA) and branched-chain fatty acids (BCFA; isobutyrate, butyrate and isovalerate) according to the protein source incorporated in the experimental diet of rats (N=7).

The nature of the protein and, to a lesser extent, the cooking procedure have significant incidence on:

(1) the microbial composition of the caecal content. Plant-based diets are associated with higher abundance of Firmicutes than meats-based diets and control diet.

(2) SCFA and BCFA productions in the caecum. The proportion of BCFA is higher in rats fed meats-based diets.

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Contact: Christine.Poelaert@ulg.ac.be

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