VRIJE UNIVERSITEIT BRUSSEL

**FACULTY OF SCIENCES AND BIOENGINEERING SCIENCES**
RESEARCH GROUP OF INDUSTRIAL MICROBIOLOGY AND FOOD BIOTECHNOLOGY
Prof. Dr. ir. Luc De Vuyst
Prof. Dr. ir. Frédéric Leroy
Prof. Dr. Stefan Weckx

# VACANCIES

The **Research Group of Industrial Microbiology and Food Biotechnology (IMDO)** of the **Department of Bioengineering Sciences (DBIT)** of the **Vrije Universiteit Brussel (VUB, Brussels, Belgium)** wants to hire

seven **PhD students** to perform doctoral studies

Each of these collaborators will contribute to an internally or externally financed research project. It concerns the following subjects and projects:

## 1) Interaction of lactic acid bacteria and yeasts during sourdough fermentation

Sourdough is a mixture of flour and water that is fermented by lactic acid bacteria (LAB) and yeasts, either spontaneously or after addition of a starter culture. Initially, the focus of IMDO's sourdough research was on the species diversity, community dynamics, and metabolite kinetics of sourdough fermentations using conventional cereals such as wheat, rye, and spelt, as well as using alternative cereals, such as barley, oat, and teff. Recently, focus is on the expression of non-expressed, so called sleeping genes of pathways relevant for enhanced aroma formation by the addition of specific ingredients. To study these fermentation processes, both laboratory fermentations with flour as the sole non-sterile component and fermentations made under bakery conditions are carried out. This PhD research project aims at getting insights into the aroma and taste formation of liquid and firm, active sourdoughs within a reasonable processing time. Indeed, the aroma and taste of the bread crumb is mainly determined by the yeast fermentation. However, conventional bakers' yeast activity is limited in time with the currently applied baking practices. Active sourdoughs, based on the activity of both LAB and non-conventional yeasts, may offer an interesting alternative for the bakery practices. Yet, sourdough preparation is also time-consuming. Therefore, it is challenging to examine how flavour formation can be steered during wheat sourdough fermentation through interactions between LAB and/or yeasts by means of appropriate co-cultures, to ultimately improve the bread flavour and taste and enhance presumptive health-promoting properties. This research will be financed through a university project. It will make use of microbiological (both culture-dependent and culture independent methods) and metabolomic analyses.

**2) Inter-relationships between arabinoxylan-enriched flour and the sourdoughs and breads produced thereof**

The use of sourdough in bakery products is increasing strongly, not only because of the natural and traditional character of this cereal fermentation product but also because of its impact on the aroma, taste, shelf-life, and health-related aspects of the final bakery product. This impact may be accentuated by the use of starter cultures (industrial sourdoughs) to replace spontaneous fermentation processes (artisan bakery sourdoughs). However, the impact of the quality of the flour, regarding both its nutritional and microbial composition, on the sourdoughs produced is not known in detail yet. Concerning its nutritional composition, the arabinoxylan content of the flour may be of great influence on the sourdough microbiota development. Moreover, there may be an impact of such sourdoughs on the bread dough processing and final bakery products. This PhD research project will deal with the impact of arabinoxylan-enriched flour on the microbial ecology, substrate consumption/conversion, and metabolite production/conversion during sourdough fermentation by means of microbiological (both culture-dependent and culture-independent methods) and metabolomic approaches. This research project will be financed by the Flemish government (cSBO project of Flanders' FOOD).

**3) Field-cereal-flour-sourdough-bread axis regarding microbial species diversity**

Artisan bakery sourdoughs are often characterized by a typical microbiota, often determined by the house microbiota, the flour and/or ingredients used, as well as the process conditions applied. Moreover, it has been shown that organic cereal production influences the development of the sourdough microbiota. Evidently, the flour is fundamental regarding nutrient availability and physicochemical parameters for the establishment of stable microbial consortia within a short fermentation period, so that only those species and/or strains that are very well adapted to the sourdough ecosystem will thrive. Competitiveness may thus, at least partially, explain the association of certain lactic acid bacteria species and/or strains with specific sourdough fermentation processes and bakery conditions. However, other factors may play a role as well, such as the agricultural practices and flour production. This PhD research project will examine the field-cereal-flour-sourdough-bread axis, making use of both microbiological (culture-dependent and culture-independent methods) and metabolomic analyses. This research project will be financed partly by an artisan bakery company.

**4) Cocoa bean fermentations initiated with selected yeast starter cultures**

Cocoa bean fermentation is the first step in the curing process of raw cocoa beans before the fermented and dried cocoa beans can be used for chocolate production. The cocoa bean fermentation process is still a spontaneous process that facilitates the drying of non-germinating cocoa beans by pulp removal as well as stimulates colour and flavour development of fermented dry cocoa beans. As it is carried out on-farm, cocoa bean fermentation is subjected to various agricultural and operational practices and, hence, fermented dry cocoa beans of variable quality are obtained. Spontaneous cocoa bean fermentations carried out with care are characterised by a succession of particular microbial

activities of three groups of microorganisms, namely yeasts, lactic acid bacteria (LAB), and acetic acid bacteria (AAB), which results in well-fermented cocoa beans. Whereas the species diversity of LAB and AAB is rather restricted, that of yeasts is much broader. Hence, the choice of a candidate yeast starter culture has to be examined in more detail. This PhD research project aims at performing starter culture-initiated cocoa bean fermentations in cocoa-producing countries using various combinations of interesting strains of species of yeasts, LAB, and AAB to compose functional starter cultures not only for an improved cocoa bean fermentation process but also to carry out steered fermentations regarding flavour and health-related compounds. Both microbiological (culture-dependent and culture-independent methods) and metabolomic analyses will be performed. This research project will be financed by the Flemish government (FWO-SBO project).

**5) Technological microbial consortia in fermented meats without nitrate/nitrite and the associated hazard of *Clostridium botulinum***

Fermented meats are produced by the activity of particular species of lactic acid bacteria (LAB) and coagulase-negative staphylococci (CNS) in the presence of (curing) salt(s). However, these salts are under scrutiny because of the potential association with the risk of colon cancer. As a result, a persistent market demand for process modifications has been created, including for instance a search for clean-label products prepared without nitrate- and nitrite-containing curing salts. However, curing is not only essential for proper colour and flavour development but also for food safety purposes. In such framework, a need for improved pathogen control is of paramount importance. Indeed, removing nitrate and nitrite may, for instance, augment the incidence of the deadly pathogen *Clostridium botulinum*. The objective of this PhD research project is to make use of bacteriocinogenic LAB and CNS to sufficiently control some key pathogens that may arise in modified process technologies, in particular with respect to the effect of nitrite/nitrate-lowering or removal. To facilitate the assays, use will be made of atoxigenic knock-out mutants of *C. botulinum* in collaboration with an external partner. Gene expression studies applying transcriptomics (RNA-seq) will be applied to investigate adaptations of (and possible interactions between) the bacteriocinogenic LAB or CNS with the *C. botulinum* strains at gene level. The data will also be coupled to microbial community analysis and species diversity as well as metabolic data obtained from metagenomics and/or chromatography and mass spectrometry. The strategies will be explored in liquid meat simulation models in bioreactors and in meat batter models, and ultimately validated on pilot-scale level within a broader project set-up that will involve different academic partners as well as members of the industry. This research project will be financed by the Flemish government (FWO project).

**6) Impact of the terroir on the quality of lambic beers**

Lambic beers are traditionally produced in Belgium in the proximity of the Senne river valley through the spontaneous microbial inoculation of wort, which is prepared from barley, unmalted wheat, aged dry hops and water, that initiates a long-lasting fermentation and maturation process carried out in wooden barrels. It results in a noncarbonated sour-tasting beer. Recently, it has been shown that the wooden barrels are an additional inoculation source of microorganisms, besides the brewery air and processing equipment. The unique and

complex flavour of these beers originates from the metabolic activities of various yeasts, lactic acid bacteria, and acetic acid bacteria. This PhD research project aims to unravel the impact of the agricultural practices, environmental air inoculation, and barrel fermentation and maturation on the microbiota and flavour development, making use of microbiological (both culture-dependent and culture-independent methods) and metabolomic analyses. This research project will be financed through a university project in collaboration with an artisan lambic brewery.

**7) Impact of submerged fermentation during wet processing on the coffee cup quality**

Before coffee can be consumed as a beverage, the coffee cherries undergo a long post-harvest processing chain. Two widespread processing methods are applied, namely wet and dry processing. During dry processing, the coffee cherries are sun-dried to obtain the green coffee beans. The wet processing encompasses several steps, starting with the depulping of the coffee cherries, followed by a submerged fermentation process of the coffee beans, soaking of the fermented beans, drying of the soaked beans, and dehulling of the parchment beans, which results in the final green coffee beans. Green coffee beans are to be roasted and grinded before coffee can be brewed. The final coffee flavour is not only determined by this roasting and brewing process, but also by the post-harvest coffee processing chain. This PhD research project aims at unravelling the key steps of the post-harvest processing chain of wet coffee processing that are important in determining the coffee flavour. It will focus on the underwater fermentation process and examine the diversity and role of the microorganisms involved as well as test the use of functional starter cultures of lactic acid bacteria and/or yeasts to have an impact on the coffee quality (both green coffee beans and cup quality). Both microbiological (culture-dependent and culture-independent methods) and metabolomic approaches will be used. This research project will be financed through a university project in collaboration with the University of Costa Rica.

**Profile:**

The candidate has a university degree of MSc in Bioengineering Sciences (Chemistry and Bioprocess Technology or Cell and Gene Biotechnology) or equivalent, with a vast knowledge of and interest in (food) microbiology, biochemistry, bioinformatics, fermentation technology, and/or food technology. Important additional qualifications are: sense of initiative, team spirit, sense of responsibility, motivation and dynamism, hard-working, persistence, stress resistance, and good communication and reporting skills. Good knowledge of the English language (oral and written) is required.

**We offer:**

A young, creative, dynamic, pluralistic, and international working atmosphere. Possibilities for national and international cooperation with renowned laboratories and companies. Interesting work field with many perspectives for a future career. Salary as PhD student.

**All vacancies mentioned above can be filled in immediately. If you are interested, please take contact with and send your curriculum vitae to:**

**Prof. Dr. ir. Luc DE VUYST**
**Vrije Universiteit Brussel - IMDO - Pleinlaan 2 - B-1050 Brussels - Belgium**
**Tel: 02/629 32 45 - Fax: 02/629 27 20**
**E-mail: luc.de.vuyst@vub.be**
**Website: http://imdo.vub.ac.be**