General data	
PPP number	**AF-15503**
Title	**Evolutionary Trade-offs in dairy fermentation**
Theme	**Gezond&Veilig**
Executing research organisation(s)	**WUR, VU Amsterdam, NIZO**
Project leader research (name + email address)	**Herwig Bachmann; herwig.bachmann@nizo.com**
Coordinator (on behalf of private parties)	
Contact person of government	**onbekend**
Total project budget (k€)	**1818 kEuro**
Project website address	**https://www.tifn.nl/project/evolutionary-trade-offs-in-dairy-fermentations/**
Starting date	**1 oct 2016**
Final date	**Dec 2021**

Approval coordinator/consortium The annual report has to be discussed with the coordinator/consortium. The TKI(s) like to be informed regarding potential comments on the annual report.	
The annual report is …… by the coordinator on behalf of the consortium	□ approved □ not approved
Potential comments regarding the final report	

Description content/aim PPP	
Description of problem	In engineering and economics trade-offs are well known. Similarly, evolutionary trade-offs in microbial cells are defined as the optimization of one trait at the cost of another. For instance, if a cell puts lots of energy into the production of costly molecules like exo-polysaccharides little energy is available for cell growth. This project focuses on the influence of trade-offs on industrial fermentations. We will investigate the role for key enzymes in dairy fermentations including enzymes involved in growth, (post-) acidification, flavor- and texture formation. Industrially relevant parameters will be investigated including temperature, salt, starvation and pH stress. These conditions change rapidly throughout cheese manufacturing and we will investigate how these changes influence functionality of the starter culture in the fermented dairy product.
Goals of the project	The goal of this project is to generate knowledge that allows to improve industrially relevant topics in dairy fermentation such as the development of new starter cultures, shorten lag-phases, increase flavor formation, shorten cheese ripening times and improve the robustness of the fermentation process.

Results	
Expected results 2019	The expectation for 2019 was to use the so far developed protocols to identify and characterize trade-offs in dairy fermentation. The focus was on combining phenotypic data with proteome and transcriptome analysis

	and use modelling approaches for their better understanding. For the relevance in dairy applications milk should play a bigger role as substrate.
Achieved results 2019	Cultures of lactic acid bacteria harvested at conditions where trade-offs are expected were analyzed at different levels including transcriptome, proteome, metabolites and enzyme activities. Besides work in chemically defined medium these efforts were extended to experiments in milk and cheese. A modelling framework was developed to integrate the data described above and which made predictions on cellular constraints that may determine trade-offs possible. Several findings on potential trade-offs are currently being investigated for their potential in dairy applications. The aim is to improve the dairy production process and functionality of starter cultures and give more control over the starter culture and cheese manufacturing as well as cheese ripening.
Expected results 2020	The steering possibilities during the dairy manufacturing processes will be investigated for identified trade-offs. This should lead to industrially relevant process optimizations. The results will be reported in scientific publications and should result PhD thesis (the contracts of several PhD students will finish at the end of 2020). The focus in the coming year will be on the finalization of the experiments and preparations of peer reviewed scientific publications.

Delivered products in 2019 (give titles and/or description of products, or a link to the products on the project website, or other public websites).
Scientific articles:
External reports:
Professional articles in journals:
Lectures/posters during workshops, conferences and symposia: Posters: 1. Douwenga *et al.* Nutrient quality but not growth rate influence the adaptive response of *L. lactis* 2. Van Olst *et al.* The molecular business plan of environmental adaptation in *L. lactis* 3. Pelt-KleinJan *et al.* Proteome constrains explain metabolic changes in *L. lactis*

4. Nugroho *et al.* Manganese inhibits metabolic activity of non-growing *L. lactis*
TV/radio/social media/newspaper:
Others (techniques, machines, methods, etc.):