ANTARCTICKER: Molecular mechanism of keratin waste degradation by Antarctic bacteria and characterization of its bioactive products

Extremophiles are microorganisms living in the challenging environments, often experiencing one or several extreme abiotic factors, such as low or high temperature, highly acidic or alkaline pH, high UV-radiation, high pressure, high salt and heavy metals concentrations, etc. Thanks to significant molecular adaptations, they had to develop in order to survive, a variety of them became **sources of industrially important biomolecules with unique properties**. With more than 80% of Earth's biosphere permanently experiencing temperature below 5°C, it is recognized that **cold-adapted microorganisms are potentially one the most abundant group of extremophiles**. Thanks to significant advancement in omic sciences scientists are now able to gain a deeper insight into molecular mechanisms and industrial potential of this exceptional microorganisms. Currently, they are mainly known for producing technologically interesting biomolecules, some of which have already achieved commercial success.

Keratin is the third most abundant biomass in nature, occurring in all vertebrates as an integral part of epidermis and its appendages (hair, wool, feathers and etc.). It is a protein biopolymer with a complex structure, high stability and low solubility, determining its high resistance to degradation by conventional proteolytic enzymes. **As a result of global meat production, keratin-based waste becomes more and more burdensome stream of waste to manage.** It is estimated that in 2020, the European Union's poultry meat production generated around 3.2 million tonnes of feather waste. In Denmark alone around 17.5 million pigs are slaughter each year, resulting in generation and accumulation of significant mass of waste bristles and hooves. **If not managed properly, keratin-based waste streams can significantly affect natural ecosystems and human surroundings, contributing to environmental pollution and posing a hazard to human and livestock well-being**. Proper management and recycling of this valuable by-product is therefore considered a necessity from the point of view of sustainable development and circular bioeconomy.

Due to the significant negative impact on the environment, conventional methods of keratin waste management are regarded as unsustainable. Therefore, keratin bioconversion with the use of keratin-degrading microorganisms and their enzymes is considered as an interesting alternative. Unfortunately, most of conventional enzymes possess limited stability and activity in typical industrial conditions, hence novel, more resistant homologs are of a great interest. **Extremophilic enzymes, which are naturally tailored to catalyze reactions in the environments, where activity of their conventional counterparts would be significantly reduced or completely inhibited, are and ideal fit here.** Implementation of cold-adapted bacteria and their extremozymes to generate functional keratin hydrolysates and other by-products in lower temperatures would be additionally advantageous due to the relatively lower energy consumption. However of many known keratinolytic bacteria, only few of them are representatives of cold-adapted microorganisms.

The aim of this project is **to investigate six strains of cold-adapted bacteria** from our own collection, **for their keratin-degrading abilities**. To assure safe and rational utilization of keratin waste selected cold-adapted strains have to be undergo genetic and biochemical characterization. Therefore**, the proposed project is designed to implement multifaceted omics studies (including genomics, proteomics, and metabolomics) to identify key enzymes and metabolites involved in the low temperature keratin waste degradation process**. Based on the acquired data, potential mechanism for enzymatic degradation of keratin waste involving selected cold-adapted bacteria will be proposed. **The project involves the analysis of keratin hydrolysates, obtained from the degradation of waste substrates, for bioactive properties, including antimicrobial and antioxidant activity, as well as cyto- and genotoxicity.** The results of this project will become a groundwork for the future development of new, sustainable methods of keratin waste management, focused at obtaining hydrolysates with high added value. These hydrolysates can then utilized as innovative plant biostimulants, fertilizers, components of microbial media or functional additives for animal feed.