Group	Physical Chemistry and Soft Matter & Organic Chemistry
Project	Pushing the boundaries: Comparative exploration of amyloid fibril formation in food animal and plant proteins
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Introduction

Food proteins are non-toxic, sustainable, and affordable in nature. Food-derived protein amyloid fibrils (PAF), especially animal protein amyloid fibrils, have been employed as advanced materials in biomedical, environmental and biomaterial applications. Both intrinsic and extrinsic conditions have been concluded to affect self-assembly of PAF, thereby modulating the multi-scale structures, morphology, and techno-functional properties. Given the rapid global population growth and significant environmental issues, plant proteins are considered as ideal alternatives to animal proteins due to their abundance, availability, and sustainability, compared to animal proteins. However, current knowledge on the microscopic steps of plant proteins, temporal-spatial polymorphisms, and correlated mechanical properties, remain elusive. These problems arise from the diverse composition, low purity and heterogenous subunits of plant proteins. Furthermore, the curly nature of plant protein amyloid fibrils limits their development into functional materials.

Keywords: Food protein, amyloid fibril, aggregation, microscopic steps, mesoscopic morphology, AFM, AFM-IR, nano-mechanics

Aim:

To address these challenges in plant amyloid fibril production, you will compare animal proteins and plant proteins to understand physicochemical differences determining the formation of amyloid fibril useful to produce materials.

Objectives:

This project involves extracting or purifying specific animal vs. plant food proteins with balanced subunits that were previously characterized to form amyloid fibrils. Statistical analysis will be performed based on polymer physics and machine learning algorithms. Examples of research objectives in this project are:

A. Compare differences of microscopic steps between animal and plant amyloid formation. Well-defined fluorescence assays will be applied to characterize aggregation kinetics of animal vs. plant proteins. Quantitative analysis of the fluorescence assays will be performed to study microscopic mechanisms of aggregation.

B. Gain insights into bulk physico-chemical differences between animal and plant proteins during aggregation. Differences on multi-level protein structures will be characterized based on SDS-PAGE, circular dichroism (CD), infrared and fluorescence spectroscopy. Statistical analysis will also be employed.

C. Unravel differences between animal and plant protein at single aggregate level. Cutting-edge Atomic Force Microscopy (AFM)-based techniques will be used to characterize morphological features, infrared chemistry and nano-mechanics of amyloid fibrils.

What you will learn:

- ✓ Purification and Extraction of Plan Proteins.
- ✓ Acquire and Analyse Spectroscopic data (FTIR, Fluorescence, CD)
- ✓ Nanoscale imaging using AFM
- ✓ Quantitative analysis of AFM data

Requirements

- Full-time available (start mid 2024)

Contact Dr. Francesco Simone Ruggeri, *simone.ruggeri@wur.nl* for more details.