Assessment of Lipid Oxidation in Food and its Effects in Living Organisms

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This PhD project aims to assess the degree of lipid oxidation products present in long shelf-life commercial food and to verify the effect of a lifelong consumption of food containing rancid oil in a living organism. This will be tested using *in vivo* models of both *Drosophila melanogaster* (DM) wild type and DM with Parkinson’s disease. The effects of this diet will be evaluated on the degree of oxidation of their cells, and, on their microbiota determining if and how this diet may affect the evolution of Parkinson’s disease.

Valutazione dell'ossidazione Lipidica degli Alimenti e dei suoi Effetti negli Organismi Viventi

Questo progetto di dottorato mira a valutare il grado di ossidazione dei lipidi presenti negli alimenti commerciali a lunga conservazione e a verificare l'effetto di un consumo sistemico di alimenti contenenti olio rancido in un organismo vivente. Questo sarà analizzato utilizzando il modello *in vivo* di *Drosophila melanogaster* (DM) sia wild type che DM ingegnerizzata per sviluppare la malattia di Parkinson. Verranno valutati gli effetti di tale dieta sul grado di ossidazione cellulare, l'eventuale effetto sul microbiota, analizzando se, e come, questa dieta influenzi l'evoluzione del morbo di Parkinson.

# **1. State-of-the-Art**

Lipid oxidation is a series of reactions that negatively influences the shelf-lifeof food (Barden and Decker, 2016). There are various factors that could affect lipid oxidation in food, like for example the presence of free fatty acids, transition metals, heme proteins, the degree of fatty acid unsaturation, atmospheric or singlet oxygen, lipoxygenase, and environmental factors such as temperature, light and water activity (McClements and Decker, 2000), but also food technologies used to prepare it (Liu et al., 2023). Lipid oxidation and the products that derive from this process are widely known, what is unknown is the toxicity of this molecules and if or how they affect human’s health. Gut microbiota is affected by diet, and by the concentration and the composition of dietary lipids; but the mechanisms by which lipids affect gut microbiota are not well defined (Schoeler and Caesar, 2019). On the other hand, the gut-brain-axis is firmly established (Mayer et al., 2021). For this reason, it could be interesting to study the effect of lipid oxidation products both on the microbiota balance and on the neurodegenerative diseases, that are strongly connected with intestine health (Quigley, 2017). *Drosophila melanogaster* is one of the most widespread *in vivo* models used to study molecular mechanisms, genetic inheritance, and some diseases such as Alzheimer or Parkinson (Nitta and Sugie, 2022). However, these flies have also been used as a model for the study of lipid metabolism because they have many similarities with mammalian metabolism, and it is known that in these animals the lipid metabolism is also involved in neuronal diseases (Huntington’s disease, Alzheimer’s disease, and Parkinson’s disease) (Aditi et al. 2016).Humans consume lipid oxidation products every day, so the aim of this study is to understand if and how rancid oils contained in food induce lipid peroxidation in living organisms (*Drosophila melanogaster*) and if these products modulate evolution of neurodegenerative disease like Parkinson, acting on the microbiota.

# **2. PhD Thesis Objectives and Milestones**

This Project is under joined supervision of University of Camerino and University of Massachusetts and it develops as described in Figure 1.

## **Phase I, University of Camerino, aiming at:**

1. Development of protocol for stable emulsions oil-in-water (Extra Virgin Olive Oil fresh and rancid);
2. Verify if it is possible to feed *Drosophila melanogaster* with a lipid enriched diet;
3. Verify the effect of a lifelong lipid (fresh and rancid) enriched diet in wild-type DM on longevity, oxidative stress and expression of genes related to inflammation; collection of gut samples for subsequent analysis of the intestinal microbiota;
4. Verify the effect of a lifelong lipid (fresh and rancid) enriched diet in Parkinson model of DM on longevity, oxidative stress and expression of genes related to inflammation; collection of gut samples for subsequent analysis of intestinal microbiota.

## **Phase II, University of Massachusetts, aiming at:**

1. Analysis of all Drosophila’s gut samples to evaluate the abundances of the microbiota;
2. Analysis of food complex systems during storage, evaluation of lipid oxidation products and their toxicity;
3. Testing these products in an *in vivo* model.

## **Phase III, Writing and editing thesis and papers.**

***Table 1***Gantt diagram for this PhD thesis project divided in months (from December 2022 to December 2025).



# **3. References**

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