# Salmon Gravlax Biopreservation: Impact on organoleptic properties, microbial ecosystem and volatilome

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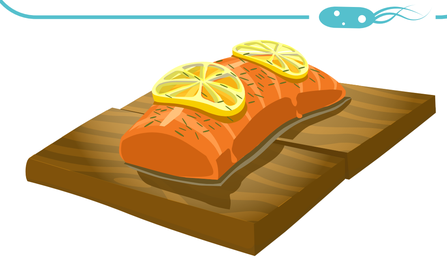
## 1. Introduction

Seafood and fishery products are very fragile commodities with a short shelf-life as the consequence of organoleptic and microbiological qualities quick deterioration. Spoilage, resulting from microbial growth and activity, is responsible for up to 25% of food losses in post-harvest and industry[1]. In this context and to meet the consumer's demand for minimally processed food, developing mild preserving technologies such as biopreservation, represents a crucial challenge. In this work, we studied the impact of 6 lactic acid bacteria (LAB), selected by Wiernasz *et al*. (2017)[2], used as bioprotective agents on dill Gravlax microbial ecosystem, organoleptic properties and volatilome.

## 2. Methods

6 LAB strains[2]:

*Carnobacterium maltaromaticum* SF1944
*Lactococcus piscium* EU2229
*Leuconostoc gelidum* EU2249
*Vagococcus fluvialis* CD264
*Carnobacterium inhibens* MIP2551
*Aerococcus viridans* SF1044



Inoculated at $10^6$ CFU/g

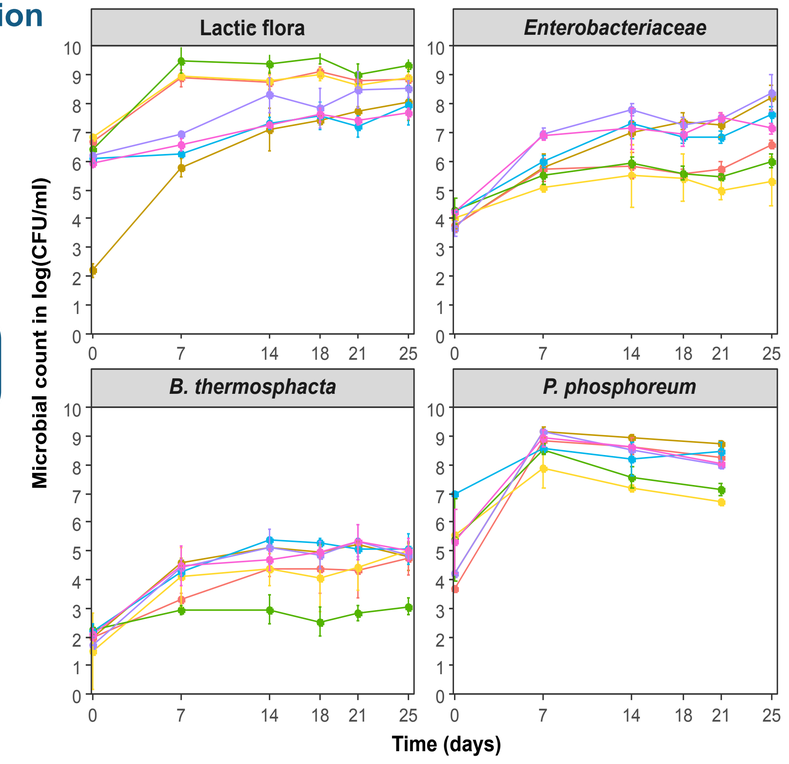
Gravlax characteristics:
Shelf-life of 21 days
Vacuum packed
Stored at 8 °C from day 0 to 25

## 3. Results

### 3.1. Microbial enumeration

**Figure 1**. Evolution of different microbial flora during storage, in presence of the 6 LAB. *B. thermosphacta* was enumerated on STAA, lactic flora on NAP, *Enterobacteriaceae* on VRBG and *P. phosphoreum* by q-PCR targeting the luxA gene.

Slight inhibition exerted by *C. maltaromaticum*, *L. piscium* and *L. gelidum* on main spoilage bacteria.




### 3.2. Biochemical analyses

- pH: quick acidification for *L. piscum* and *L. gelidum* (cooked aspect).
- No significant differences with the control for the 6 biogenic amines quantified (histamine, tyramine, cadaverine, putrescine, spermine, spermidine).
- Significant decrease in gravlax TVBN content in presence of *L. piscium, L. gelidum*, *C. inhibens* and *A. viridans.*
- No Trimethylamine production during storage.

### 3.3. Impacts on sensory quality

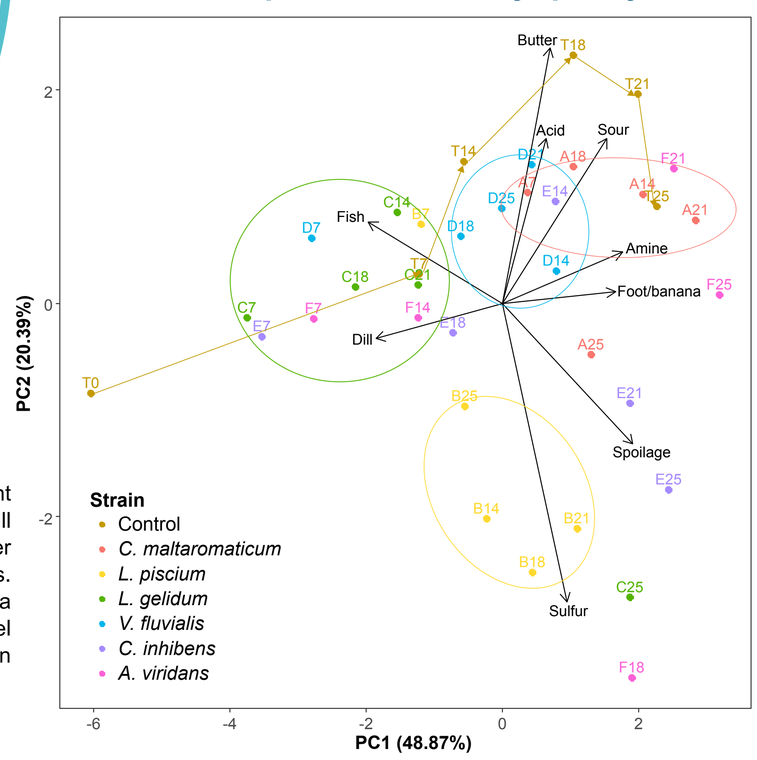
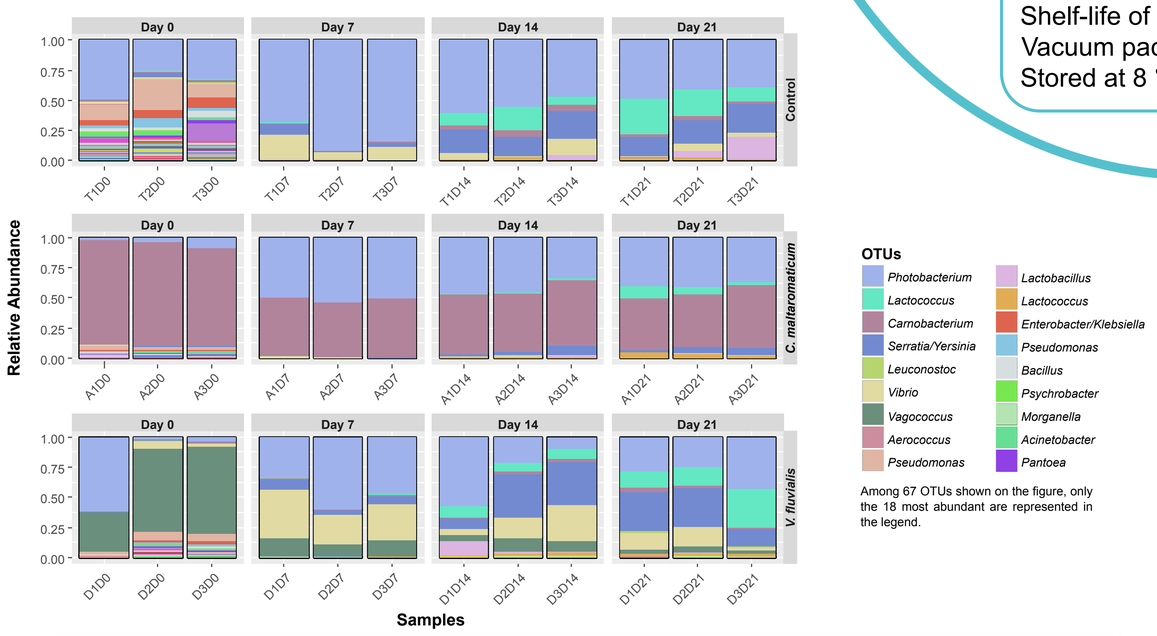



**Figure 2**. Principal component analysis (PCA) representation of dill Gravlax slices sensory profiles after inoculation with the 6 LAB strains. Odor descriptors were scored on a scale from 0 to 10 by a trained panel of 20 juges. PCA was performed on descriptors scores mean.

- Control was strongly spoiled after 21 days with mainly amine and acid odors.
- Although very close to the control, *V. fluvialis*, was the only strain able to improve and maintain the sensory quality to an acceptable level after 25 days.
- *C. maltaromaticum* was associated with foot/banana and sour odor.
- *L. piscium* related to a strong sulfur odor production after only 7 days.
- *L. gelidum* was a good canditate with dill and fishy odor until 21 days, but a production of gaz and slime was visible after only 14 days.

### 3.4. Gravlax ecosystem monitoring through metabarcoding

**Figure 3**. Ecosystem evolution during storage. The hypervariable region V4 of the 16S rRNA gene was targeted[3]. Amplicons were sequenced with Illumina MiSeq technology and output data were treated with FROGS pipeline[4]. On bar plots of ecosystem composition, only figure results obtained for the control and samples inoculated with *C. maltaromaticum* and *V. fluvialis.*




Among 67 OTUs shown on the figure, only the 18 most abundant are represented in the legend.

Two patterns were observable:

- *C. maltaromaticum*, *L. piscium*, *L. gelidum* were well implanted in the product and remain predominant during storage.
- *V. fluvialis*, *C. inhibens*, *A. viridans* were not competitive and became a minority after 1 week of storage (ecosystem closed to the control).

## 4. Conclusion

The 6 LAB effect on dill gravlax quality could be classified in two main scenarios:

I) *C. maltaromaticum*, *L. piscium*, *L. gelidum* were competitive in the product by dominating the ecosystem till the end of the experiment, expressed antimicrobial activity against spoilage bacteria but also against *Listeria monocytogenes* (data not shown), and possessed their own sensory signature and volatilome specificity.

II) *V. fluvialis*, *C. inhibens*, *A. viridans* were not well implanted at the gravlax surface, with a sensory and volatilome profil very closed to the control, and did not demonstrate antimicrobial activity. Nevertheless, *V. fluvialis* maintained the gravlax sensory quality below the rejection threshold after 25 days (control was rejected after 21 days).

**Biopreservation of naturally contaminated products remains complex to apprehend and may further relies on metabolic interactions between microorganisms from an ecosystem more than antimicrobial activity.**

## 5. References

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