Blåmat satellite project - Freshwater fish for Sweden

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1.0 Introduction

Promoting sustainable consumption of Swedish freshwater fish in Sweden can be a strategy to reduce our reliance on imported seafood (currently over 70%) and allow diversification of national small-scale businesses. Freshwater fish can have a low carbon footprint, but their consumption in Sweden is continuously declining since mid-20th century, subsequently causing a loss of tradition and knowledge of how to prepare them. When compared to marine other seafoods, freshwater fish can have different sensory properties and higher small bone frequency, making consumers dismayed and hesitant in utilizing them. To facilitate the re-introduction of freshwater fish into the Swedish diet, suitable products specific for Swedish consumers need to be developed. Moreover, when developing a new fish product, it is important to valorise possible by-products. Fish by-products often contain high commercial value components such as protein and oil, which can be used for maximal utilization of the food-grade side streams. waste. The goal of this project is to contribute to guidelines for the development of future freshwater fish products for Swedish consumers based on a minimal waste (head-to-tail) approach.

The aims were:

- To determine preparations that could have potential for Roach fish to be marketed as a fish product
- Qualitatively understand consumer's perceptions of Roach fish and potential as commercially available product
- Determine the feasibility of producing fish sauce from side streams.

2.0 Methodology

The work will be performed on the freshwater fish common roach (mort *R. rutilus*), which will be provided by Guldhaven Pelagiska AB. The project comprised three work packages (WPs): WP1 – Prototyping, WP2 - focus group, and WP3 - Minimal waste.

2.1 Prototyping

Frozen roach fillets and whole fish (heads, tails, and entrails removed) were provided by Guldhaven Pelagiska AB in August of 2022. Product prototypes were prepared with the aim to mimic products that are currently consumed in Sweden, i.e. canned and steaming. Subsequently the fillets, whole fish, and pieces of whole fish were stored in water and/or oil to simulate canning and other processes. The optimal processing conditions were selected to take the samples further to focus

group with consumers in WP2. Steaming, cooking under heated pressure and steaming were performed at RISE.

2.2 Focus group

As the inception of the idea in utilising the fish common roach as products potentially for the Swedish market is underdeveloped, qualitative data will be collected from consumers. Data were be collected from a focus group consisting of seven Swedish members of the public who are regular fish product consumers (canned, marinated, preserved, and smoked fish). Qualitative questions were be asked by a focus group leader to gather consumer's opinions and attitudes about their usage of processed fish products. This was followed by tasting the prototypes produced in WP1 together with a commercial Finnish product (i.e. marinated and processed roach). The commercial products (smoked version and tomato sauce version, both canned) served as a reference to what the sample could be, in which the prototypes are attempting to partially emulate. The performance of the prototypes were be discussed upon tasting by the focus group participants. Specifically questions around points of improvement in the prototypes and agency thereof were be discussed. WP2 were performed at RISE and the consumers were not told that the samples were roach fish until the very end of the focus group.

2.3 Fermentation

Fermentation of by-products can increase the quality of protein hydrolysates, oil and produces antioxidant compounds. The side streams were provided by Guldhaven Pelagiska AB, frozen. The side streams were blended until homogenous, heated (65°C for 15min), and enzyme treated with the following steps. Initially 0.25% alcanase was incorporated for 2hrs. These were then heated at 90°C for 10 min and cooled to 4°C. The mixture was then heated to 50°C with 0.5% proteinase for 4hrs. This was followed by 90°C for 10 min and cooled to 22°C. The treated blend were added with 10% NaCl and inoculated with microbial starter cultures (*Candida sake* and *Debaryomyces hansenii separately*) as well as samples without inoculation (controls). Samples were fermented for 28 days. The pH, yeast/total cell counts, and free amino acids were measured throughout the fermentation procedure.

3.0 Results

3.1 Prototyping

Various preparations were made including steaming temperature, cooking time, and the carrier being either oil or water. After benchtop tasting of the all prototypes, three suitable preparations were identified (Table 1. And Fig 1.).

Table 1. Roach fish preparation parameters most suitable for focus group presentation.

SAMPLE	FISH CUT	COOKING	COOKING TIME	CARRIER
1	Fillet	Steam 100 °C	4 min	Oil
2	Fillet	Steam 100 °C	4 min	Water
3	Whole	Pressure	90 min	Oil

Fig 1. Three samples chosen for focus group testing, from left to right, samples 1 to 3. See table 1 for processing parameters of each sample.

The decision to use these parameters were primarily based on sensory characteristics. Specifically for fillets that were steamed at 70°C were unpalatable with the flavours of earth and mud. Steaming at 100°C stored in oil on the other hand had minimal minimal fishy or earthy characteristics and texture characteristics that were similar to commercial canned fish. Pressure cooking for 90 min was optimal for the integrity of fish meat and soft bones. Pressure cooking of pieces of fish resulted in extensive disintegration.

3.2 Focus group

The outcomes of the focus group revealed the current state of how roach fish is perceived generally, as well as the performance of the prototypes upon tasting (Fig 2). Consumers were asked about their opinions on freshwater fish and from some of the participants, roach fish was spontaneously mentioned without being prompted specifically to answer about specifically this fish. This spontaneous mention of roach revealed just how bad a reputation it has. Interestingly, the participants did not know the reason for the bad reputation.

In terms of sensory performance, appearance played a role in appeal of prototypes (colour and bones). The pressure cooked fish was perceived as similar to canned tuna. When tasting the commercial products, these were positively received. Further consumers could see themselves purchasing and consuming smoked product.

When the consumers were revealed the identity of the all participants were pleasantly surprised after revealing the type of fish. Bones were however an issue, despite their edibility from pressure cooked samples. Potential agency of canned and flavoured products were more obvious to the participants where situations were even mentioned where such products could be consumed. Interestingly, despite the commercial samples containing bones, the participants did not realise and consumed the pieces whole without picking out the bones.

3.3 Fermentation

The aim of fermentation of the sidestreams were to investigate this as a proof of concept with fish sauce as a model. After 28 days of fermentation, the liquid of the samples on visual inspection did not appear sauce like. In all samples, the pH decreased from 6.48 to between approx. 6.1 and 6.2 (Fig 3.). For some samples there was a gradual increase in pH again, while with other strains the increase in pH did not begin until after day 23.

Fig 2. Presentation of roach fish prototypes and commercial products.

Total cell counts of the samples only detected colony forming units (CFU) in the inoculated samples that contained *C. sake* and *D. hansenii*, but not in the reference sample that were uninoculated (Fig 4). These organisms were therefore able to withstand the conditions of the sample with 10% NaCl without competition of other microorganisms.

Free amino acids were measured in the samples with varying strains. In both instances, inoculation with both *C. sake* and *D. hansenii* had increased the total free amino acids (Fig 5a). This was reflected in the individual free amino acids, though there did not seem to be the case for cysteine, ornithine, and proline (Fig 5b).

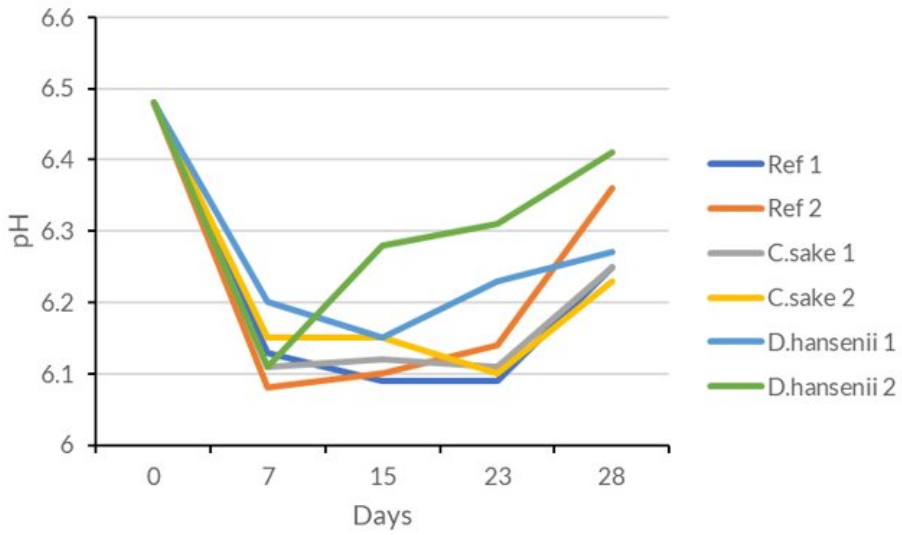


Fig 3. pH progression as a function of time and different strains used for inoculation.

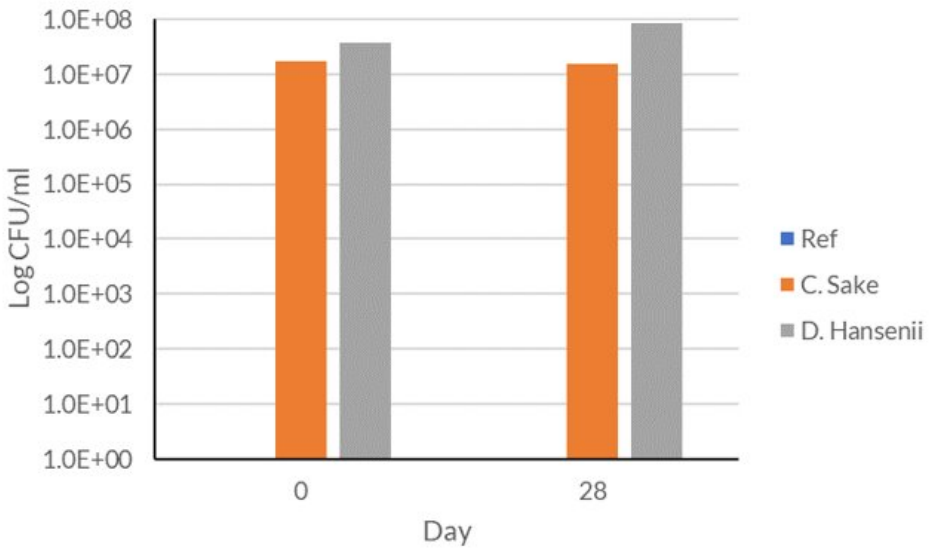
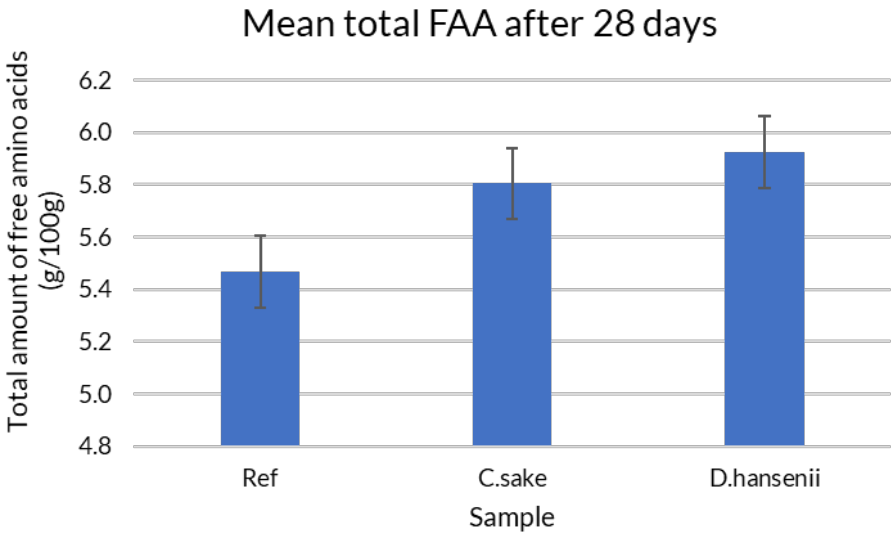


Fig 4. pH progression as a function of time and different strains used for inoculation.

a).



b).

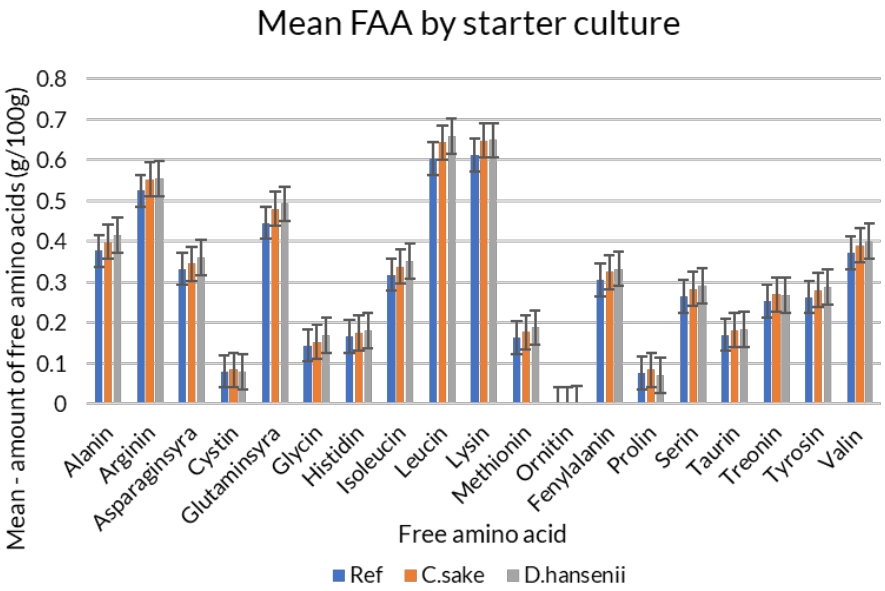


Fig 5. Amino acid measures after 28 days of fermentation for a) total and b) free amino acid

4.0 Conclusions

Preparation methods of the roach fish had an impact on the sensory outcomes. The most promising however were cooking at high temperatures for steam or by pressure cooking. The appearance played a large role in the appeal of roach fish, indicating that the first impressions are important. Preparations of roach fish as flavoured such as the commercial samples could have potential in the Swedish market, especially the smoked version. Therefore, further optimisation of the product with flavouring is necessary in order to increase its acceptance by consumers. Both tested yeast strains survived in the fish side streams with 10 % salt. After 1 month the number of viable cells increased indicating their potential as cultures for production of fish sauce. Further studies are needed to investigate fermentation time with strains and also their impact on sensory perception.

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