Creation of improved alt-seafood flavours

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Abstract

This project will perform a deep dive into the molecular basis of seafood flavour (volatile & non-volatile) and advance the current state of knowledge.

New non-animal flavour ingredients will be identified and formulated in appropriate plant-based (PB) seafood matrices to create improved alt-seafood flavours for use in the creation of popular alternative seafood species - white ocean fish, salmon, tuna, squid, prawn and scallop.

Background

There is great commercial potential for PB seafood, however there are significant challenges in getting the flavour and texture right. Many commercial PB products lack authentic taste and flavour. Good flavour (and texture) are key to consumer acceptance and uptake. Fresh seafood flavor is complex and delicate and difficult to recreate. Although a lot is already known, there are knowledge gaps, especially when trying to mimic seafood flavours in PB systems. We aim to create new knowledge and know-how for the creation of more acceptable alt-seafood flavours.

Methods

- *Systematic literature review summarising the current state of knowledge of seafood flavour & relevant chemistry.*
- *Fresh seafood samples obtained from Sydney Fish Market & commercially available PB seafood from various sources*
- *Volatile signatures of seafood & commercially available PB seafood will be measured by solid phase microextraction (SPME Arrow - Carboxen/DVB/PDMS fibres) & gas chromatography-mass spectrometry (GC-MS-QP-2020-NX, Shimadzu).*
- *Sensory evaluations performed by a trained seafood panel.*
- *Targeted and non-targeted metabolomic profiling of seafood species using hydrophilic interaction chromatography-LC-MS with Deep Scan AcquireX workflow conducted @ Metabolomics Australia, Bio21 Institute, Melbourne University*
- *Elemental analysis of seafood and PB performed @ UNSW*
- *Based on these insights, PB ingredients, flavours and precursors will be formulated in alt-seafood matrices and tested with sensory feedback*
- *Key outcomes and recommendations reported*

Preliminary results

12 seafood & 11 PB seafood samples were investigated. Notably, the macro-nutritional profiles of PB seafood (e.g. prawns, calamari, sashimi) were very different to seafood, with a very low protein content (**Table 1**). Key differences between seafood & PB in sensory attributes were measured by the panel.

	Product	Origin	Ingredient notes	Fat	Protein
1	Whitefish	Taiwan	*Soy, seaweed, seaweed extract*	11	13.5
2	Calamari	Malayasia	*Konjac, curdlan, vegetable seasoning*	2.6	2.4
3	Scallop	Thailand	*Mushroom*	0.1	1
4	Salmon sashimi	Taiwan	*Konjac, flavour enhancers*	0	0.3
5	Whitefish	Malayasia	*Texturised wheat, soy, seaweed*	3.5	17
6	Calamari	Malayasia	*Battered, konjac, curdlan, vegetable seasoning*	17	1
7	Whitefish	Thailand	*Battered, soy concentrate, linolenic acid*	10	6
8	Tuna Sashimi	Taiwan	*Konjac, flavour enhancers*	0	0.3
9	Prawn	Taiwan	*Curdlan, konjac, seaweed extract*	0.7	0.3
10	Prawn	Taiwan	*Starch, curdlan, vegetable seasoning*	2.6	2.4
11	Prawn	Malayasia	*Starch, curdlan, vegetable seasoning*	2.6	2.4
12	Salmon	Australia	*Tasmania Atlantic skin on-pan fried*	20.4	13.4
13	Snapper	Australia	*Skin on-pan fried*	1.7	26
14	Calamari	NZ	*Arrow Calamari*	1.4	15.6
15	Salmon Sashimi	Australia	*Sashimi grade*	20.4	13.4
16	Barramundi	Australia	*Humpty Doo, aquaculture*	2	18.4
17	Scallop	Canada	*North Atlantic Sea*	0.5	12.5
18	Tuna Sashimi	Australia	*Sashimi grade*	0.5	24.4
19	Prawns	Australia	*Black Tiger prawn*	1	13.6
20	Scallop	Japan	*Hokkaido, Roe off*	0.5	12.5
21	Tuna	Australia	*Swordfish, skin on, steaks*	0.5	24.4
22	Prawn	Australia	*Green Tiger grilled, shell on*	1	13.6
23	Tuna	Australia	*Yellowfin, cooking grade*	0.5	24.4
24	Salmon	Australia	*Tasmania Atlantic skin on-pan fried*	20.4	13.4

• **Plant-based** • **Seafood**

Unsurprisingly, PB samples were easily discerned from and less liked than seafood counterparts (**Fig. 1**). The PB whitefish samples had strong flavour, were salty & sweet with cooked vegetable & beany flavours. Seafood samples were more liked and had more intense fishy (trimethylamine), brine/bromine, ocean spray, meaty & other attributes. Cooked salmon was associated with highest overall liking. Seaweed, seaweed extracts & α-linolenic acid were novel ingredients incorporated in some PB products to increase marine flavours.

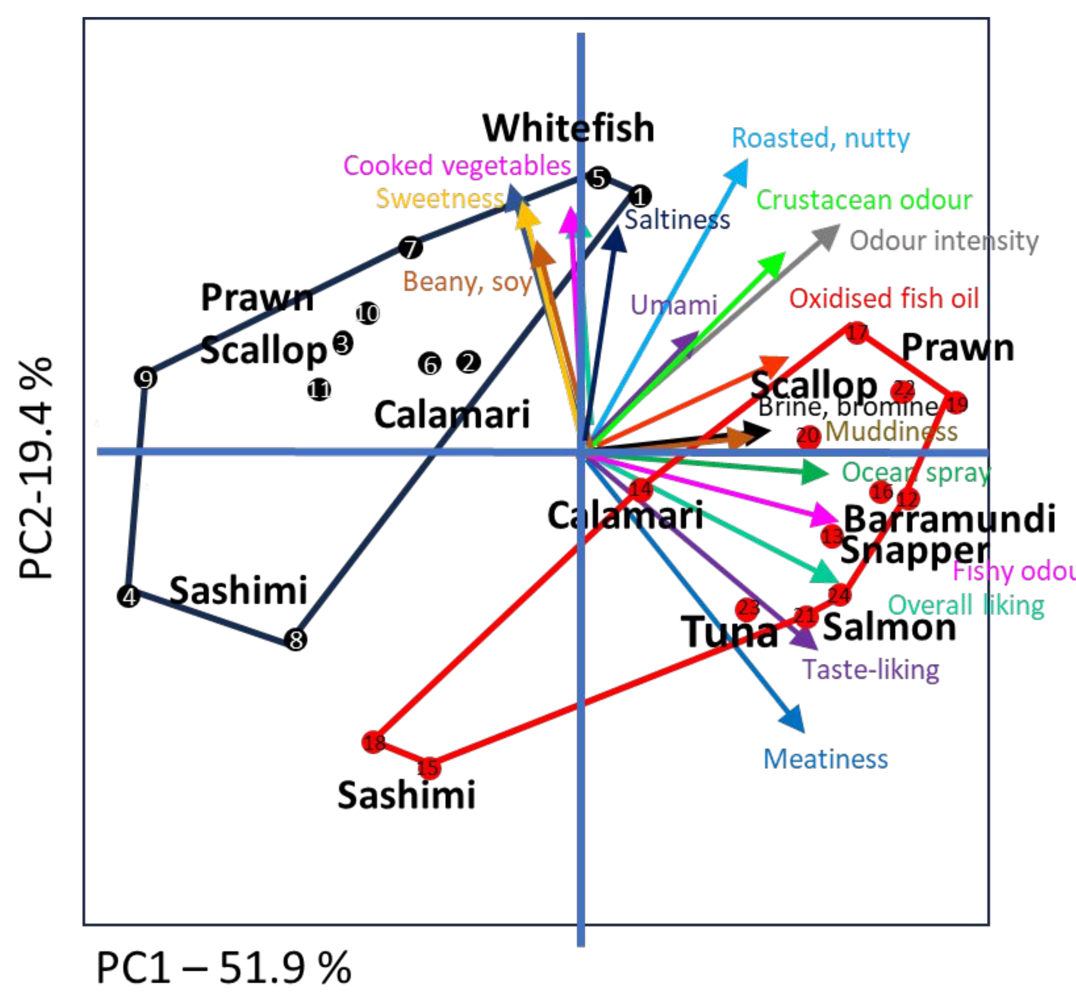

Figure 1.

PCA biplot of flavour relevant sensory attributes of seafood (red circles) and PB samples (black circles) from Table 1.

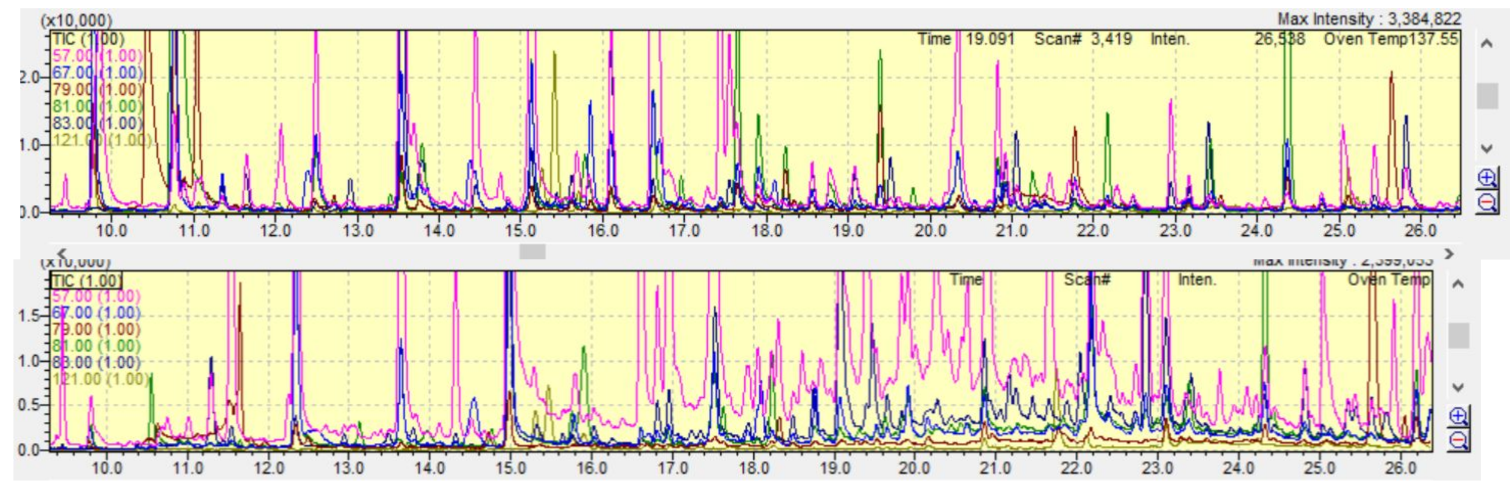

Figure 2. Typical volatile profiles of PB (top) and seafood (bottom) samples highlighting the complexity of information

More than ~200 volatiles were measured in the headspace of seafood & PB samples (**Fig 2**). Many of them are of known importance in seafood flavour (Jones *et al.* 2022*). Most "generalist" food flavour volatiles were higher in the cooked PB whitefish samples – consistent with them being over-flavoured. A subset of volatiles that differentiated seafood from PB were measured (**Fig 3**). Trimethylamine & heptanal, were generally higher in fresh seafood flavour; 2,4-dithiapentane and indole were elevated in scallop and prawn flavour. Volatiles from the oxidation of PUFAs (omega-3 fatty acids) were more dominant in other seafood samples. The PB samples were generally low or lacking in these volatiles and high in 2-pentylfuran, a volatile associated with beany/soy flavour. Salmon has a higher fat content than whitefish and had a higher concentration of lipid derived volatiles.

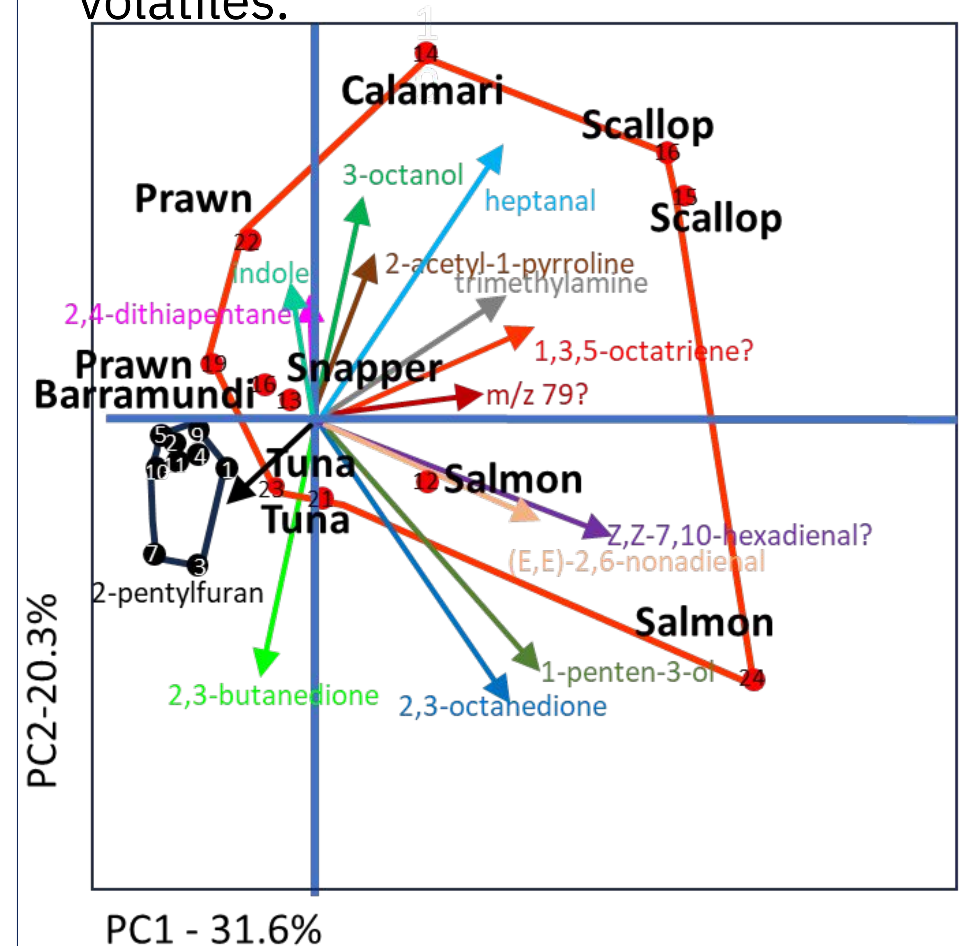

Figure 3.

PCA biplot of volatile differences between cooked seafood (red circles) and cooked PB samples (black circles) - selected subset of GC-MS volatiles only.

Preliminary data confirm that PB seafood flavour is generally different to seafood, justifying further research and effort. Drawing on existing knowledge & data mining of new information generated in this study, we aim to identify better ingredients and approaches to produce enhanced alt-seafood flavours with greater consumer acceptance.

METABOLOMICS AUSTRALIA

UNSW SYDNEY

*Jones, Rocker, Keast, et al. 2022. Systematic review of the odorous volatile compounds that contribute to flavour profiles of aquatic animals, *Reviews in Aquaculture*.