Alternative methods for utilizing zooplankton

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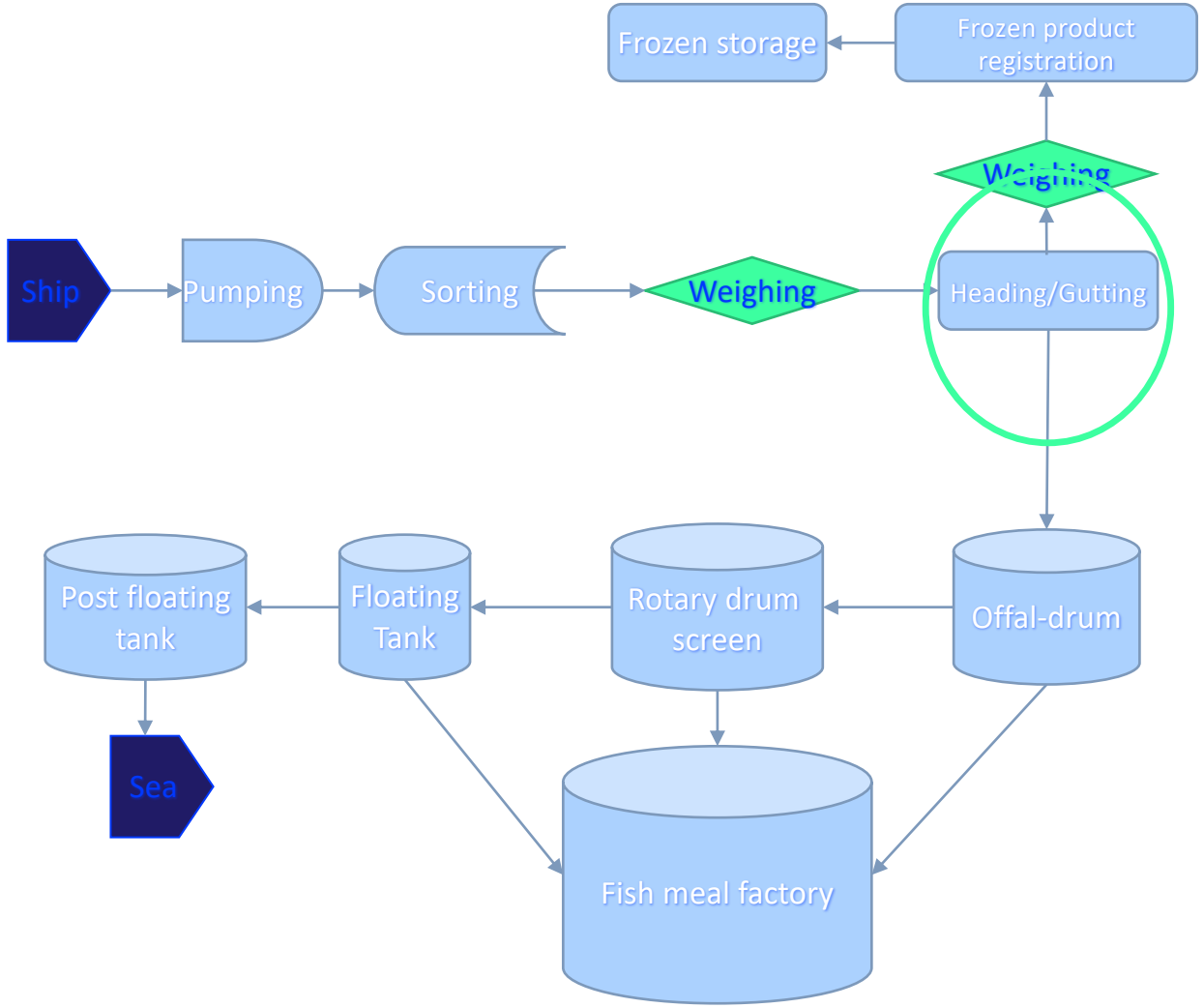
Little-Giants Workshop

Copenhagen 15.5.24

Alternative methods for utilizing zooplankton

- Main results
  - Collection of Zooplankton
  - Processing
  - Products
  - Sensory and safety

Collection of zooplankton



Collection of zooplankton

- Set up of collection equipment
- Size of mesh

Collection of zooplankton

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Collection of zooplankton

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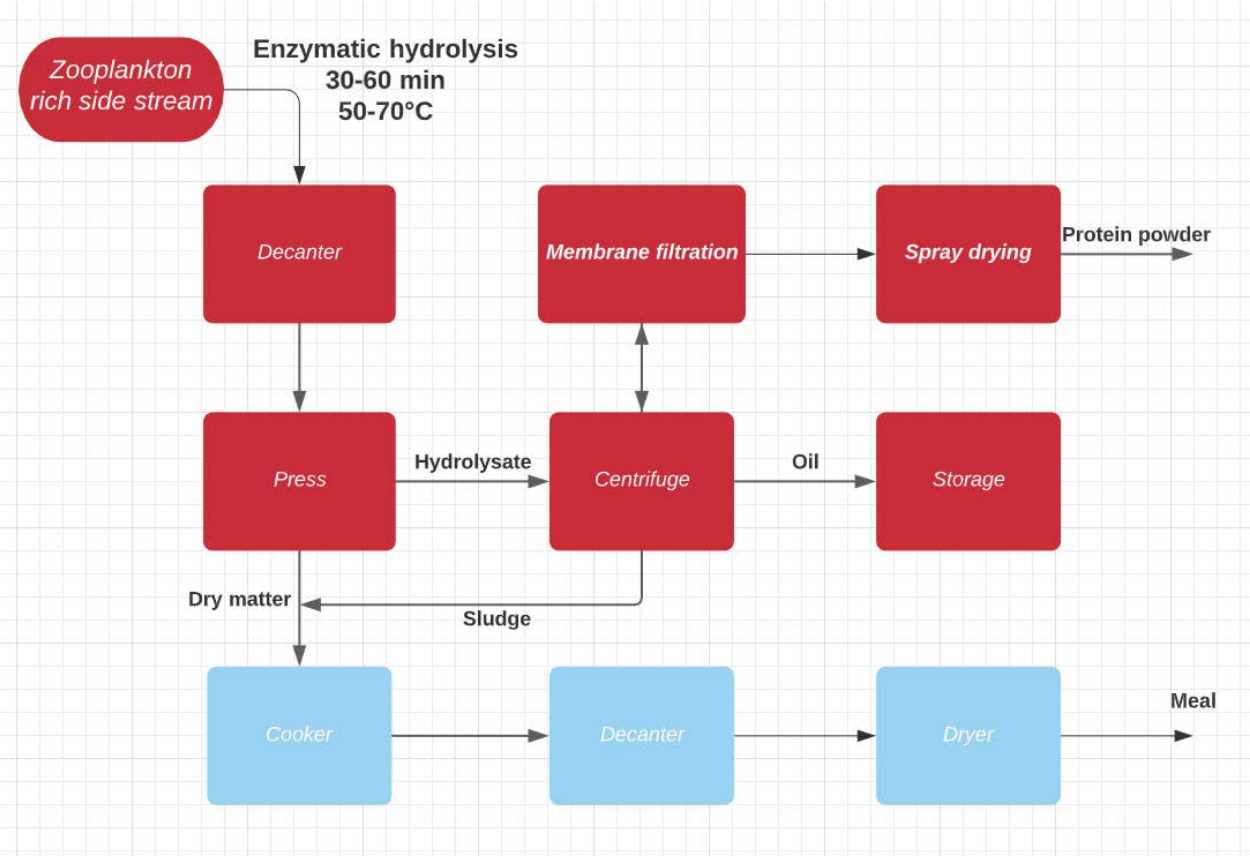
Collection of zooplankton

Collection of zooplankton

- Main issues to be overcome
  - Timing of catching
  - Separation of zooplankton from viscera
    - Knives
    - Redox drum
  - Running of equipment
  - Collection of zooplankton on board vessels

Processing


Zooplankton rich side stream
Enzymatic hydrolysis
30-60 min
50-70°C
Decanter
Membrane filtration
Spray drying
Protein powder
Press
Hydrolysate
Centrifuge
Oil
Storage
Dry matter
Sludge
Cooker
Decanter
Dryer
Meal

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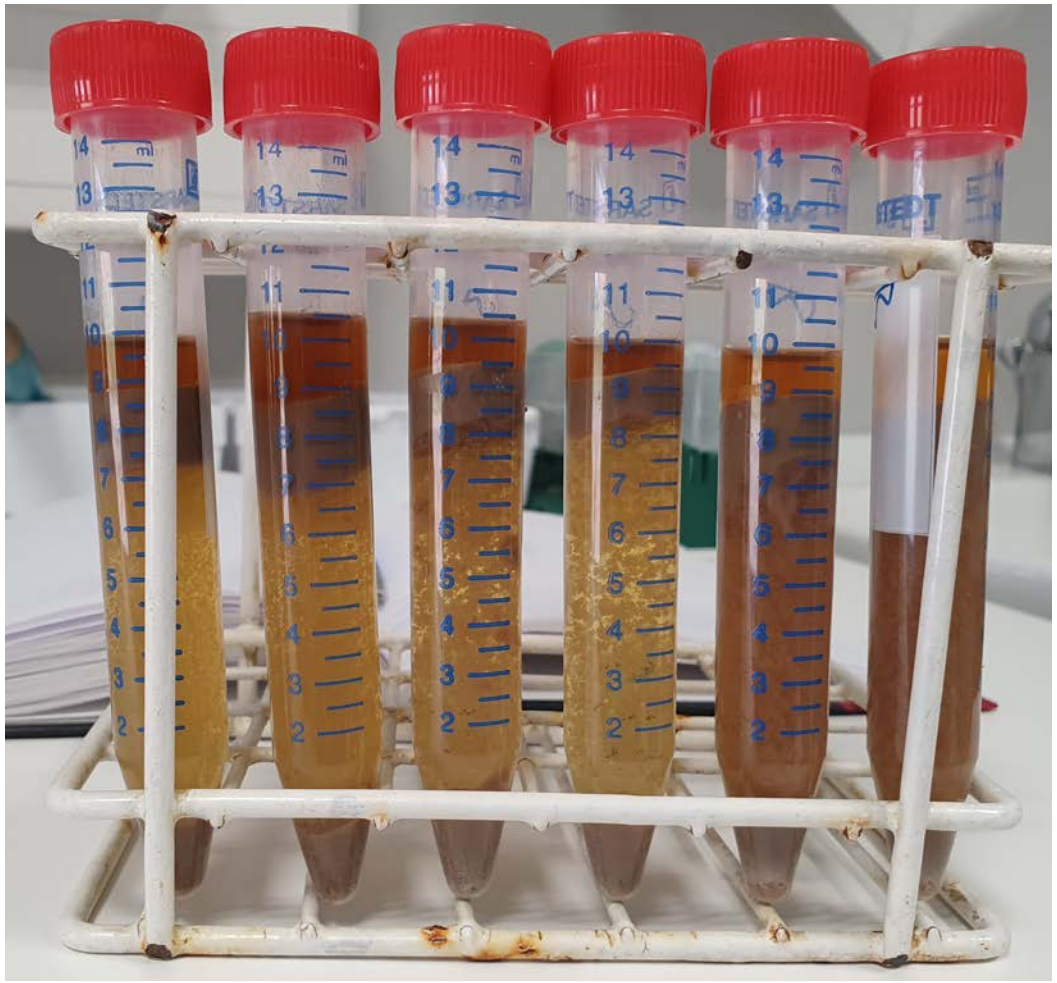
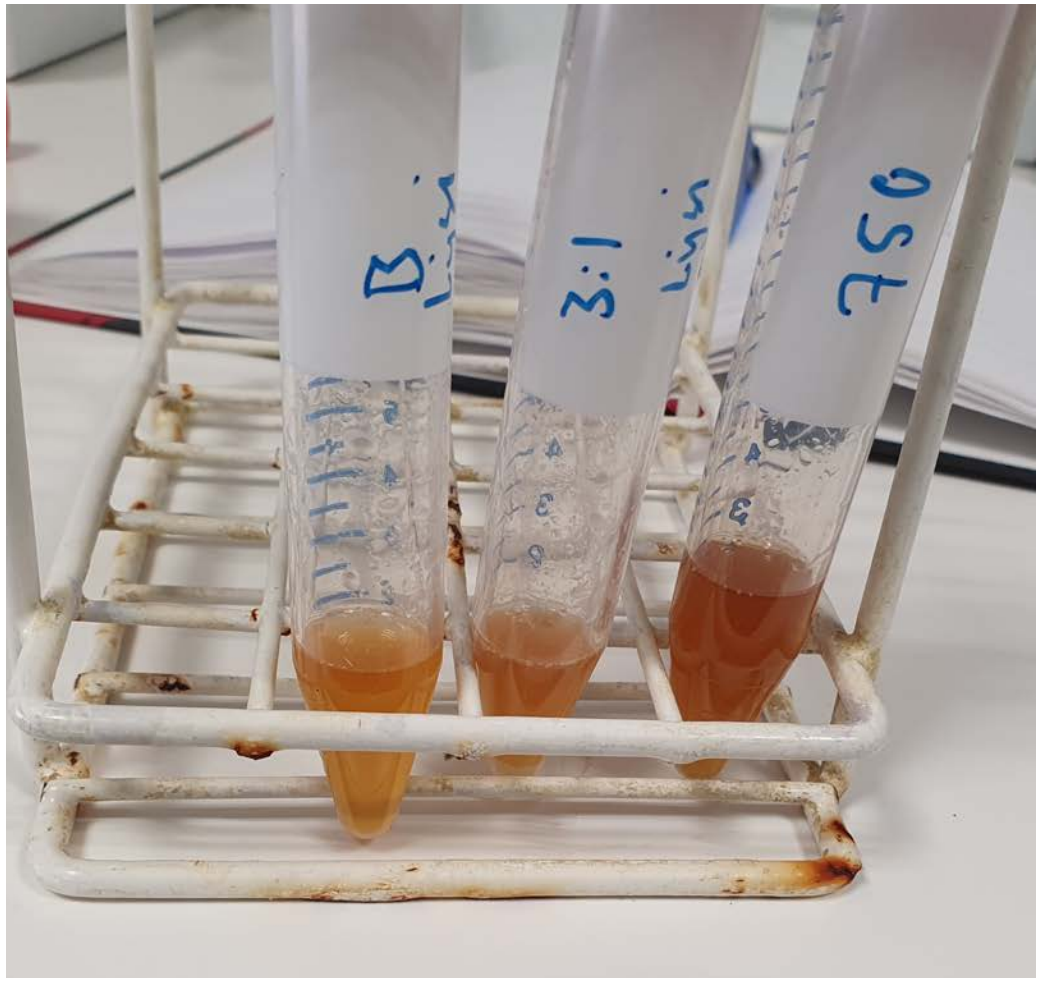
Processing





Processing

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Processing

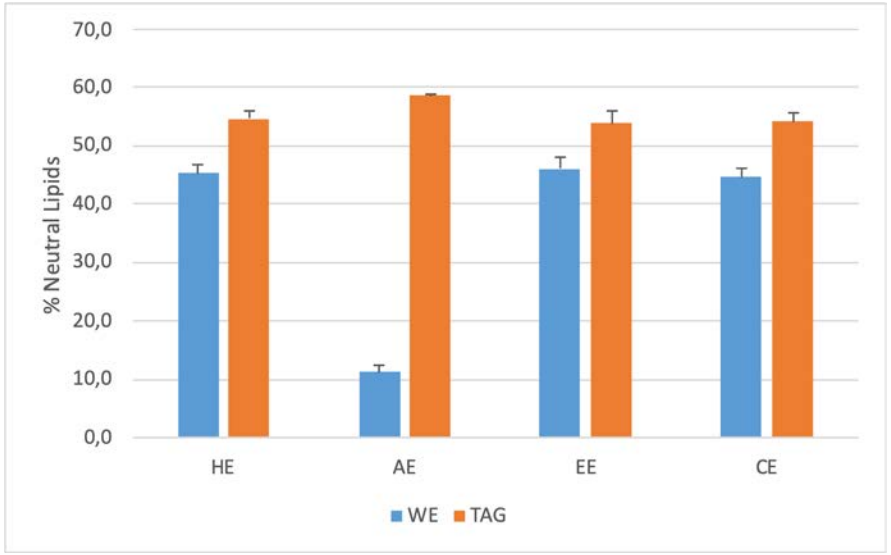
Products

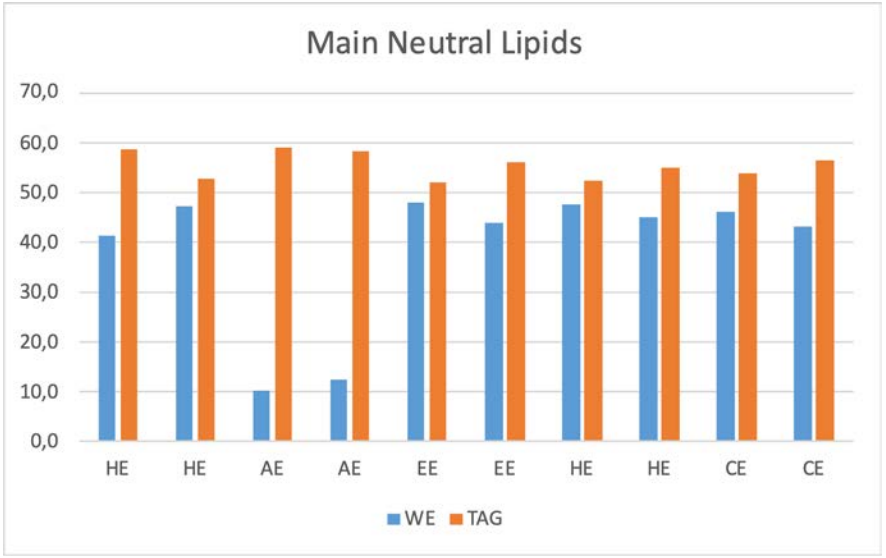
- Oil
- Proteins
- Others

Products

- Oil

Fatty acid	Oil Cold	Oil Hot	Oil Acetone	Oil Enzyme
C11:0	0.6 ± 0.0	0.6 ± 0.01	0.1 ± 0.0	0.6 ± 0.01
C14:0	6.3 ± 0.13	9.7 ± 0.34	8.5 ± 0.0	10 ± 0.0
C15:0	0.3 ± 0.01	0.5 ± 0.01	0.5 ± 0.0	0.5 ± 0.01
C16:0	6.6 ± 0.16	9.4 ± 0.14	9.5 ± 0.01	9.3 ± 0.18
C16:1n7	3.7 ± 0.07	3.4 ± 0.06	3.8 ± 0.01	3.3 ± 0.08
C16:2n4	0.2 ± 0.01	0.3 ± 0.0	0.3 ± 0.0	0.3 ± 0.01
C16:3n4	0.4 ± 0.01	0.4 ± 0.02	0.4 ± 0.01	0.3 ± 0.02
C18:0	0.9 ± 0.03	1.2 ± 0.01	1.3 ± 0.01	1.2 ± 0.03
C18:1n9	9.1 ± 0.2	8.6 ± 0.12	7.8 ± 0.03	8.2 ± 0.24
C18:1n7	1.5 ± 0.03	1.4 ± 0.01	1.3 ± 0.01	1.4 ± 0.04
C18:2n6	1.7 ± 0.04	1.6 ± 0.01	1.7 ± 0.02	1.5 ± 0.03
C18:3n6	0.3 ± 0.01	0.3 ± 0.0	0.3 ± 0.0	0.3 ± 0.0
C18:3n4	2 ± 0.04	1.8 ± 0.0	2.1 ± 0.01	1.7 ± 0.03
C18:4n3	8.7 ± 0.16	7.6 ± 0.01	10.4 ± 0.01	7.5 ± 0.07
C20:0	0.2 ± 0.06	0.4 ± 0.41	0.2 ± 0.06	0.7 ± 0.06
C20:1(n11+n9)	7 ± 0.2	6.9 ± 0.07	4.2 ± 0.22	6.6 ± 0.23
C21:0	0.6 ± 0.01	0.6 ± 0.0	0.8 ± 0.0	0.6 ± 0.0
C20:4n3	1.7 ± 0.1	1.5 ± 0.01	1.8 ± 0.07	1.5 ± 0.07
C20:5n3 (EPA)	9.9 ± 0.25	8.9 ± 0.06	12 ± 0.06	8.8 ± 0.07
C22:1n11	10.4 ± 0.36	10.3 ± 0.13	4.7 ± 0.11	9.6 ± 0.42
C22:1n9	0.5 ± 0.01	0.5 ± 0.02	0.2 ± 0.01	0.5 ± 0.02
C22:2	0.5 ± 0.01	0.4 ± 0.0	0.5 ± 0.0	0.4 ± 0.0
C22:4n6	0.5 ± 0.02	0.4 ± 0.01	0.6 ± 0.01	0.5 ± 0.01
C22:5n3	1.3 ± 0.06	1.1 ± 0.0	1.1 ± 0.02	1.1 ± 0.02
C22:6n3 (DHA)	16 ± 0.44	14.7 ± 0.25	19.5 ± 0.21	14.6 ± 0.11
C24:1n9	2.2 ± 2.1	0.8 ± 0.02	0.4 ± 0.01	0.8 ± 0.04
SFA	15.5 ± 0.39	22.5 ± 0.94	21 ± 0.08	22.9 ± 0.29
MUFA	34.4 ± 2.97	32 ± 0.43	22.5 ± 0.41	30.4 ± 1.07
PUFA	42.6 ± 1.12	38.5 ± 0.38	50.3 ± 0.42	38 ± 0.44





Products

- Oil
  - “Rich” in EPA+DHA
  - FFA
  - PV
  - Anisidin

Fatty acid	V+C	V+C
C11:0	0,2%	0,2%
C14:0	5,1%	5,0%
C15:0	0,3%	0,4%
C16:0	8,6%	7,5%
C16:1n7	3,6%	3,6%
C16:2n4	0,3%	0,2%
C17:1	0,3%	0,2%
C18:0	1,4%	1,1%
C18:1n9	9,0%	8,3%
C18:1n11	0,0%	0,0%
C18:1n7	2,0%	2,0%
C18:2n6	1,6%	1,6%
C18:3n3	1,4%	1,2%
C18:3n4	0,2%	0,2%
C18:4n3	5,0%	6,0%
C20:1n9	9,2%	8,8%
C20:2	0,2%	0,7%
C20:3n3	0,6%	0,6%
C20:4n3	1,3%	1,2%
C20:5n3 (EPA)	10,0%	9,2%
C22:1n11	13,5%	12,2%
C22:1n9	0,7%	0,6%
C22:2	0,0%	1,2%
C22:4n6	1,5%	2,0%
C22:6n3 (DHA)	14,2%	14,9%
C24:1n9	0,7%	1,1%

Sample	g FFA / 100 g lipid	PV	AV	TOTOX
Cold	1,2	ND	40,9	40,9
Hot	1,3	ND	50,3	50,3
Enzymatic	1,3	ND	49,9	49,9
V+C	2,1	8,9	28,9	46,7
V+C	2,5	7,8	27,8	43,4

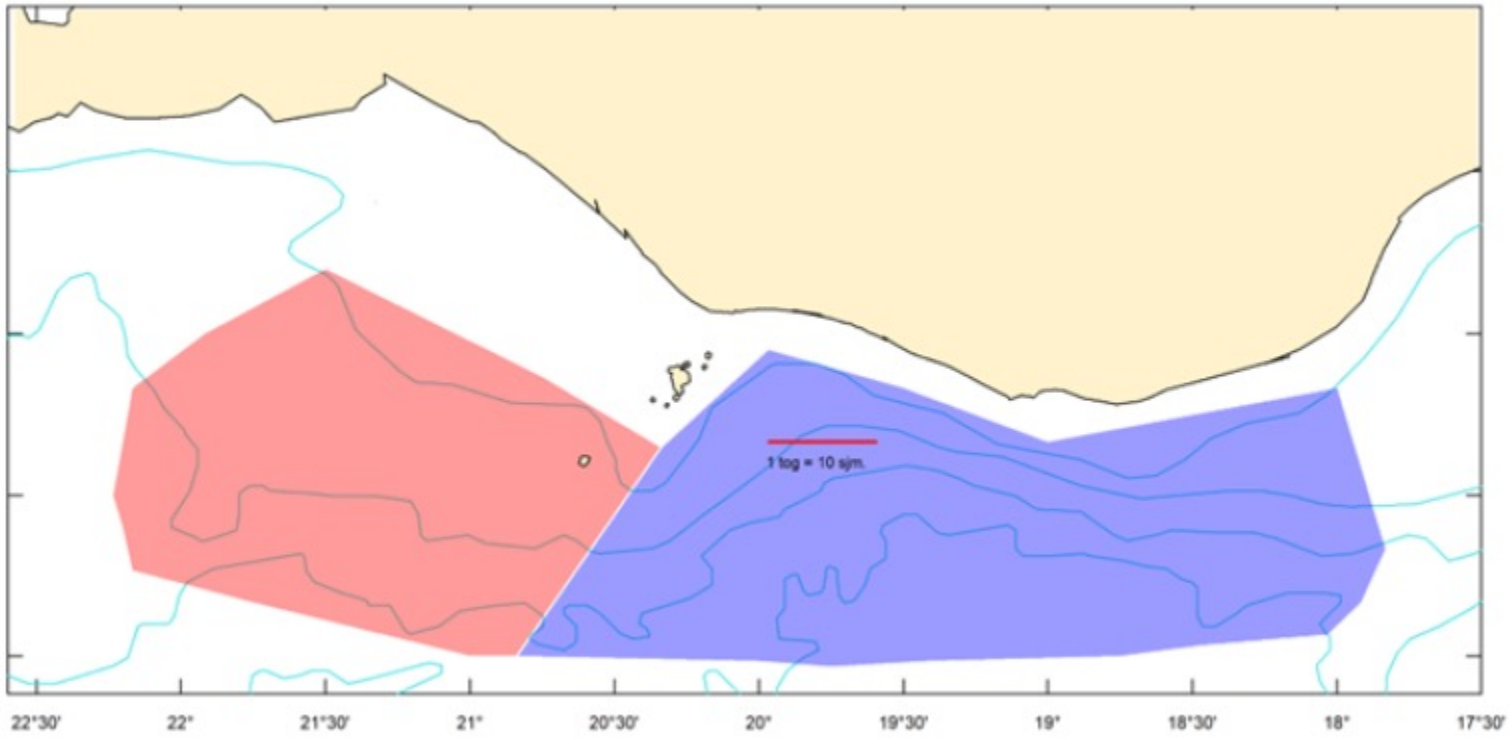
Sensory and safety

- PCBs and Dioxins
  - Raw material
  - Oil
- Heavy metals
  - Raw material
  - Oil

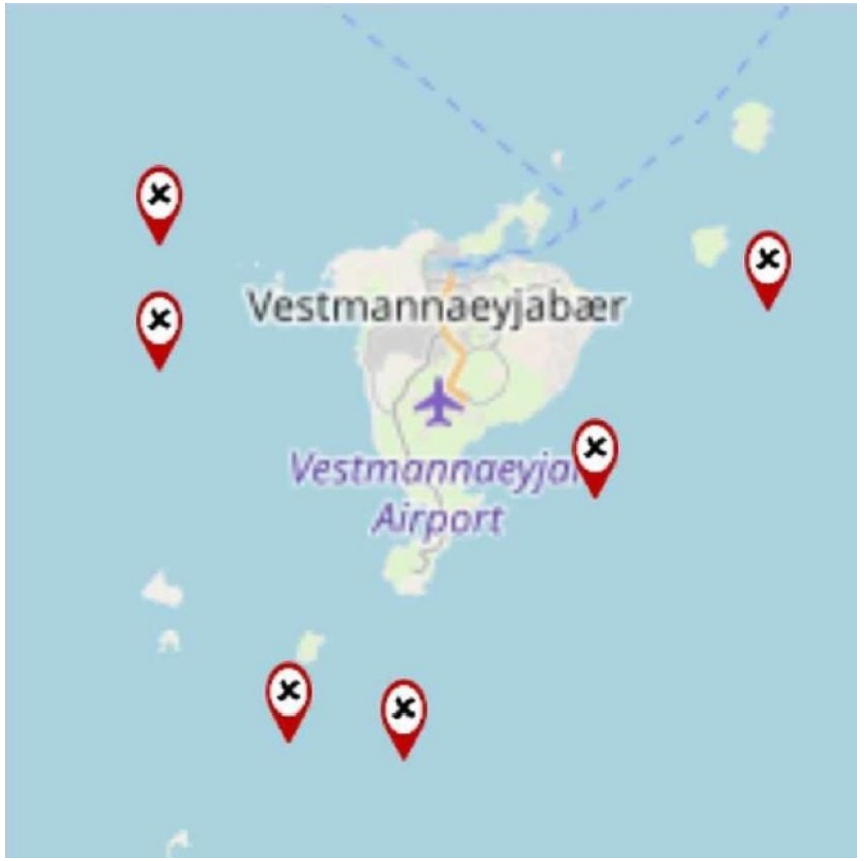
Analyte	PCDD/PCDFs (pg/g) WHO-TEQ	Dioxin like PCBs (pg/g) WHO-TEQ	Sum of Dioxins and DL-PCBS (pg/g) WHO-TEQ	ICES-6 PCB µg/kg
Raw material (calanus)	0,256	0,154	0,41	1,49
Raw material (calanus)	0,343	0,206	0,549	2
Raw material (V+C)	0,401	0,29	0,661	2,43
Oil	0,393	0,36	0,753	3,3
Oil	0,352	0,33	0,701	3,1
EU Maximum levels	3,5		6,5	75

	Oil limit	Food supplement limit	mg/kg raw material	mg/kg raw material	mg/kg V+C	**mg/kg Oil**	**mg/kg Oil**
Molybden (Mo)			0,12	0,19	0,12	<0,05	<0,05
Tin (sn)			<0,15	<0,15	<0,15	<0,05	<0,05
Cobalt (Co)			0,018			<0,05	<0,05
Mercury (Hg)		0,1	0,002	0,021	0,04	<0,03	<0,03
Iron (Fe)			16,7	7,9	11,6	5,6	4,29
Copper (Cu)			1,198	0,95	1,06	0,1	0,05
zink (Zn)			15,2	10,29	11,3	5,4	4,95
Cadmium (Cd)		1	0,803	1,73	1,22	1,12	1,06
Lead (Pb)	0,08	3	0,01	0,01	0,01	<0,03	<0,03
Arsen (As)	0,1		1,28	1,01	1,44	6,3	7,75

Experimental trials



Experimental trials



Experimental trials