



Comparison of physico-chemical and sensory properties of innovative fish spread emulsions manufactured using herring (*Clupea harengus*) milt, cod (*Gadus morhua*) roe and plaice (*Pleuronectes platessa*) roe.

Anita E. Furey^{1*}, Ulrich Hoeche², Francesco Noci²

¹Letterkenny Institute of Technology, Port Road, Letterkenny, Co. Donegal. ²Galway Mayo Institute of Technology, Dublin Road, Galway. *✉ anitafurey@associate.gmit.ie

Introduction

In Ireland, marine fish gonads are either discarded at sea or processed onshore for low-value fishmeal. Milt (male gonad) and roe (female gonad) are rich in marine oils and proteins (Slizyte et al., 2014) and considered nutritionally beneficial (Tedeschi et al., 2018) and rich in omega-3 polyunsaturated fatty acids (PUFA), an important factor in reducing coronary heart disease and cardiovascular disease (Calder & Deckelbaum, 2019). Inclusion of low-value/no-value streams in food products could increase the proportion of fish catch used for human consumption (Rustad et al., 2011). The aim of this study was to establish the feasibility of developing spreadable food products using locally sourced milt and roe to add value to this currently under-utilized nutritious seafood resource.

Materials and Methods

Two innovative ready-to-eat spreadable emulsions were developed using herring milt with, 1) cod roe (SCD) and 2) plaice roe (SPL). Fish ingredients were cooked at low temperatures to minimize nutrient loss and degradation of omega-3 PUFA. Roes were hot smoked for 7.5 m @ 90 °C and then and then steamed, while milt was poached @ 90°C. Cooked onion, garlic, potatoes and rapeseed oil were added and blended to produce a stable emulsion. Weight and moisture content of raw cod and plaice roe was measured. The products were also analysed for colour (CIE L*a*b*), instrumental texture and pH. Sensory evaluation was conducted with 86 consumers using 9-point hedonic and 5-point Just-About-Right (JAR) scales plus open-ended questions to assess attributes and acceptance. Statistical analysis included Chi-squared test on contingency tables, penalty analysis and ANOVA.

Results

Table 1 Percentage distribution of responses for Overall Liking of SCD and SPL.

Products	Hedonic Scoring*								
	1	2	3	4	5	6	7	8	9
SCD	2.3	2.3	9.3	14.0	4.7	11.6	29.1	22.1	4.7
SPL	2.3	8.1	5.8	3.5	8.1	27.9	23.3	19.8	1.2

*Hedonic scoring: 1 = Dislike extremely; 2 = Dislike very much; 3 = Dislike moderately; 4 = Dislike slightly; 5 = Neither like nor dislike; 6 = Like slightly; 7 = Like moderately; 8 = Like very much; 9 = Like extremely. SCD = cod and herring product; SPL = plaice and herring product

Table 2 Percentage distribution of Just-About-Right (JAR) and Not JAR responses for SCD and SPL (3-point scale).

Product	Fishiness		Saltiness		Savouriness		Thickness	
	JAR%	Not JAR%	JAR%	Not JAR%	JAR%	Not JAR%	JAR%	Not JAR%
SCD	(6) 56 (39)	(17) 67 (17)	(19) 68 (13)	(19) 69 (11)				
SPL	(19) 54 (26)	(18) 74 (8)	(21) 68 (11)	(17) 69 (14)				

3-point scale: (Too little) Just-About-Right (Too much)

Table 3 Contingency table showing no. of citations of like and dislike modalities mentioned by at least 5% of consumers for one or more product.

Main modalities	No. of citations	
	SCD	SPL
L_flavour	27	23
L_colour	9	8
L_texture	7	9
L_consistency	5	5
L_aria	6	4
L_appearance	3	7
L_fishiness	4	3
L_smooth	4	1
D_flavour	6	8
D_texture	6	7
D_appearance	4	8
D_aria	8	4
D_colour	5	6
D_rainy	3	7
D_fishiness	5	2
D_aftertaste	4	2
D_oily	1	4
D_mouthfeel	1	4
Total		
Like comments	65	60
Dislike comments	43	52

L = like; D = dislike; SCD = smoked cod and milt spread; SPL = smoked plaice and milt spread

Results (continued)

Table 4. Average colour values for smoked roe spreads and raw roe (n=3)

Product	L*	a*	b*
SCD	71.26 (±2.58)	2.04 (±0.66)	31.4 (±1.71)
SPL	70.30 (±0.21)	1.03 (±0.09)	27.18 (±0.30)
P-value	0.556	0.058	0.014
Cod roe raw	49.96 (±3.26)	4.71 (±1.88)	7.88 (±0.94)
Plaice roe raw†	42.87 (±1.72)	3.48 (±1.62)	1.95 (±2.27)
P-value	0.002	0.323	0.003

SCD = cod and herring product; SPL = plaice and herring product. †n=7

Milt weighed 11.5 g (± 2.2), plaice roe 14.2 g (± 7.2), and cod roe was significantly larger at 1080.9 g (± 874.5). Roe species were different in colour and moisture (P<0.05), though scored similarly by consumers for the main eating quality attributes and received positive overall liking.

Penalty analysis of JAR attributes showed that level of fishiness had the greatest negative impact on overall liking. Comment analysis, using chi-square tests, confirmed the similarity to which these products were perceived and highlighted attributes (e.g. aftertaste, bitterness) that were noticed by consumers. This shows the important role of comment analysis in providing useful attributes, for future larger scale consumer acceptance tests.

Conclusions

The favorable consumer acceptance of the prototype emulsions indicated that herring milt, plaice cod roe could be used as beneficial ingredients in the development of healthier snack food. This could offer an opportunity to add value to fish landed during the spawning season therefore reducing waste in the Irish fishing industry and contributing to a healthier diet for the consumer.

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