Trials to determine the nitrogen factor of both UK and Imported fillet and minced cod blocks

Seafish Report Number CR205
September 2004

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Seafish Technology and Training

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Report No. CR205

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Date: September 2004

Trials to determine the nitrogen factor of both UK and imported fillet and minced cod blocks.

Summary:

A Code of Practice on the declaration and labelling of fish content in fishery products was recently drawn up by participants from Industry and Enforcement Agencies. Enforcement officers will use this Code of Practice wherever there is a need to consider the correct declaration of fish content. The Code currently contains interim nitrogen factors for fish ingredient (used to determine fish content) which have been obtained by reducing the available data on nitrogen content of fish straight from the sea by amounts thought to accord with the effect of good manufacturing practice (GMP). There is a need to carry out trials to determine the actual nitrogen content of GMP products to replace these interim values.

This report is concerned with trials carried out between December 2001 and September 2003 to determine the nitrogen factor of fish ingredient of double frozen fillet and mince blocks produced under GMP in the UK. Sampling took into account both seasonality and raw-material capture area. In addition, samples were taken at key stages to determine the effect of processing. Trials were also carried out to determine the nitrogen factor of the equivalent single and double frozen blocks imported into the UK from five different countries.

For UK processed blocks the overall nitrogen content of fillet ingredient and mince ingredient was found to be 2.88% and 2.74% respectively. Processing had a significant effect on nitrogen content regardless of ground and season the nitrogen content followed a consistent pattern during the processing stages. The conversion of control to fillet ingredient resulted in no change or an increase in nitrogen whilst the conversion of fillet ingredient to final block resulted in a decrease in nitrogen. Mince block production showed a different pattern. The conversion of control to mince ingredient resulted in a decrease in nitrogen content, whilst the conversion of mince ingredient to the final block resulted in an increase in nitrogen content, whilst the conversion of mince ingredient to the final block resulted in an increase in nitrogen content.

For imported blocks the overall nitrogen content for fillet and mince blocks was found to be 2.74% and 2.67% respectively. Single frozen blocks had a lower nitrogen content than double frozen blocks at 2.64% and 2.76% respectively.

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Table of Contents:

Figures and Tables:

Appendix tables:

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1 Introduction

A Code of Practice on the declaration and labelling of fish content in fish products was drawn up by participants from Industry and Enforcement Authorities[1]. This Code covers the labelling and declaration of fish content with respect to the relevant legislation and describes the extent to which good manufacturing practice (GMP) can influence what is regarded as fish as an ingredient in fish products. It aims to assist in establishing a due diligence defence and to define enforcement procedures. Industry and enforcement officers will use this Code of Practice wherever there is a need to consider the correct declaration of fish content in fish products. This Code contains interim nitrogen factors for fish ingredient (used to determine fish content) which have been obtained by reducing the available data on nitrogen content of fish straight from the sea by amounts thought to accord with the effect of good manufacturing practice (GMP).

However the effect of water up take and/or nitrogen loss during GMP combined with the effects of other factors such as fishing ground, and seasonality are not easily quantified. Therefore, these interim factors will only be used pending the results of further measurement work by the code of practice fish nitrogen factors working group (FNFWG). The FNFWG asked the Royal Society of Chemistry (RSC) Nitrogen Factors Sub Committee to carry out this work on their behalf. The nitrogen factors arising from this work should be accepted by all parties to the Code as being the factor used in the calculation of fish content.

There is a need to determine the nitrogen factor of cod fillet fish ingredient and mince cod fish ingredient which are used as the raw material for making frozen fish blocks, which in turn are used to make many types of processed fish products.

Industry have stated that the major manufacturers of processed and breaded fish products use mainly cod fillet frozen fish blocks for the manufacture of their own and branded products. Since the introduction of the Fish Code of Practice, 80: 10: 10 blocks (80% fillet, 10% fish mince, 10% polyphosphate) are used far less. However, blocks made from minced cod are used for the production of 'economy' or 'value' processed and breaded fish products.

Over the past few years, fillet and mince block manufacture in the UK has been in a state of flux. The planning stage of this project has seen the closure of two of the large-scale UK block producers, and frequent changes in the raw material used in block production. At this time only one large-scale UK block manufacturer exists with the majority of the fish blocks being imported from abroad.

This report is concerned with trials carried out to between December 2001 and September 2003 to determine the nitrogen content of fish ingredient in the production of both double frozen fillet and mince blocks produced under GMP in the UK. Sampling took into account both seasonality and raw-material capture area. In addition, samples were taken at key stages to determine the effect of processing. Trials were also carried out to determine the nitrogen content of the equivalent single and double frozen blocks imported into the UK from five different countries.

2 Methodology

2.1 Common methodology

A Working Group was formed consisting of representatives from Seafish, Industry and a senior public analyst. A protocol for this work was put together and agreed by the RSC Nitrogen Factors Committee. Seafish carried out sample collection and dispatch for all trials. The facilities used for the collection of commercially produced GMP UK produced blocks and associated sample preparation were provided by a Humberside processor. Young's Bluecrest Seafood Ltd (Grimsby) sourced the imported fillet and mince blocks and provided facilities for the sectioning and distribution of these blocks.

Sample analysis was carried out by five UKAS accredited laboratories consisting of; the laboratory of the government chemist, two local authorities and two industry laboratories. For details of the laboratories and associated methodologies see Appendix I. Statistical support was provided by a committee approved statistician, D. Homer.

2.2 UK produced blocks

Trials were carried out using fish caught from both Barents and Norwegian Waters, in both spent and non-spent season. Before carrying out any trials the normal production process was verified by the working group to ensure GMP.

In the first trial, 1000 kg raw-material blocks made from headed and gutted (H&G) fish caught in Barents waters during the spent season (Appendix II) were obtained. The raw material and capture date was verified from the packaging and supplier. This fish was then run through the standard processing operation shown in Figure 1, the shaded boxes indicating where samples were taken. An overview of sample number and location is given in Table 1.

Figure 1. A schematic diagram showing the commercial production of fish fillet and minced fish ingredient

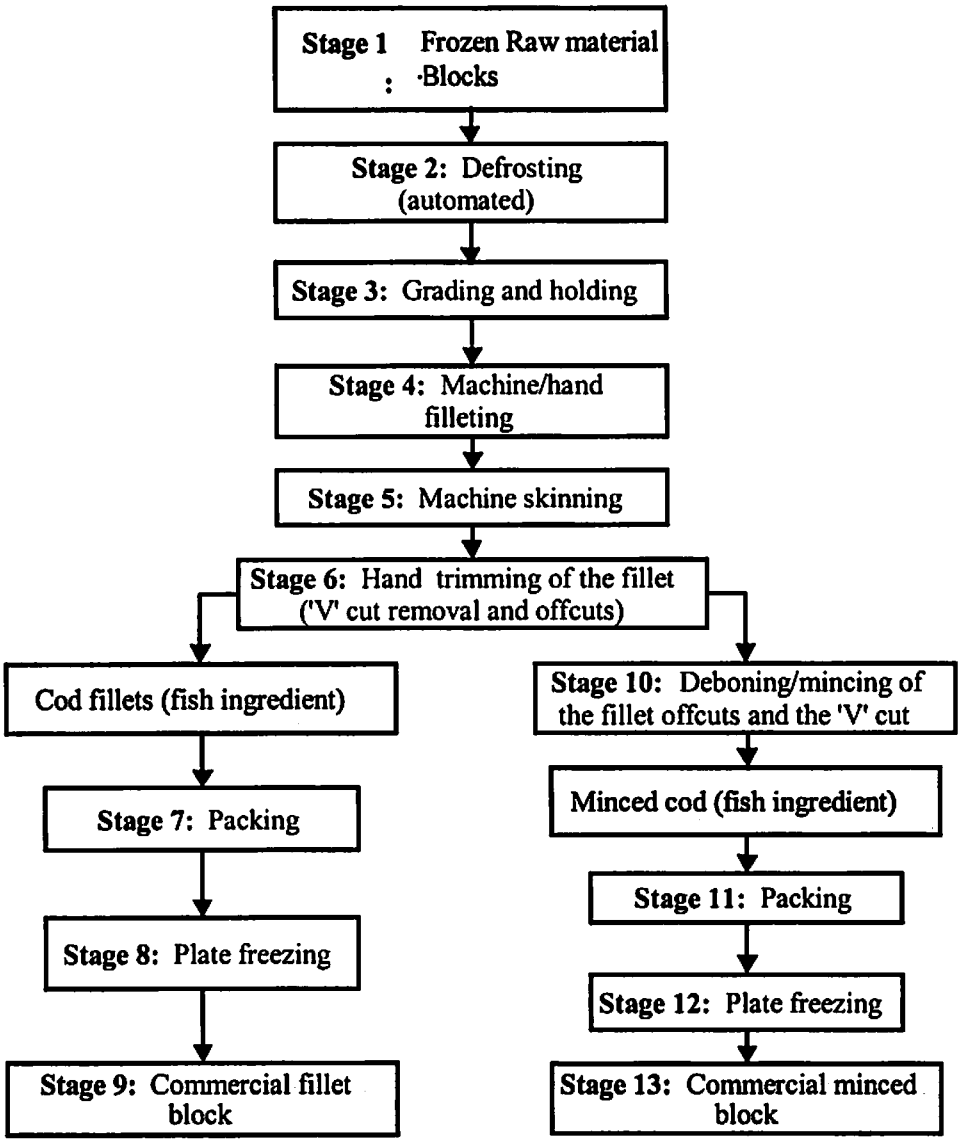

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Table 1. Summary of the number of samples of UK produced fish blocks collected for laboratory analysis.

UK produced blocks	Barents cod				Norwegian cod		Total Samples
	Spent		Recovered		Spent	Recovered	
	Hand filleted	Machine filleted	Hand filleted	Machine filleted	Hand filleted	Hand filleted	
Control (Dry filleted raw material)	20		20		20	20	400
Cod fillet ingredient	10	10	10	10	20	20	
Minced cod ingredient	10	10	10	10	20	20	
Commercial cod fillet block	10	10	10	10	20	20	
Commercial minced cod block	10	10	10	10	20	20	

To obtain control samples, five 20kg H&G frozen blocks were defrosted in air (below 10°C to minimise drip loss). A 20kg sample of defrosted fish was randomly selected, dry filleted, de boned (using the 'V' or 'J' cut method) and skinned by experienced hand filleters. Twenty, 300 gram samples (4 per laboratory) were then created by taking random fillets, which were then double bagged in heat sealed polyethylene bags.

When processing Barents fish it is normal practice to both machine fillet and hand fillet. To obtain samples for cod fillet fish ingredient and minced cod fish ingredient, approximately 5kg of material was removed at each stage for both hand filleted and machine filleted material respectively. From each five kilogram batch, ten 300 g samples were collected and double bagged. During minced cod fish ingredient production (after stage 10) liquor separation from the minced fish ingredient can occur. Care was taken to collect a representative sample.

To obtain samples from stages 9 and 13, at each stage five hand filleted and five machine filleted 7.5kg blocks were collected. For each filleting treatment the five blocks were band-sawed into approximately 10 pieces. Samples were then selected, (two from each block) and double bagged.

Each sample was labelled with an identification code (randomly generated and recorded by Seafish) and immediately frozen, and stored below –18°C. Duplicate samples were retained by Seafish.

The work was repeated with gutted fish caught from Norwegian Waters with all fish being Hand filleted.

All samples were dispatched to each laboratory by courier in an expanded polystyrene box with dry ice with instructions to be stored at -18°C or below.

This trial was repeated with fish from the non-spent season.

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2.3 Imported blocks

The original protocol proposed to source mince and fillet blocks from the five countries which commonly export these blocks into the UK; namely Denmark, Poland, Iceland, Norway and China (including Chinese blocks made from *Gadus macrocephalus)*, made from fish caught during both the spent and non spent season. This would enable comparisons to be made with fillet blocks and mince blocks produced in the UK. Appropriate audit documentation from the respective manufacturing plants ensured that GMP was practised and that the origin and history of the fish used to make the blocks was traceable.

Due to changes in fish supply conditions difficulties were encountered in sourcing blocks with the parameters originally agreed in the protocol. Seventeen different block types were obtained which were considered by industry to be representative of blocks used at this given time. . However, the blocks shown in Table 2 were agreed by the RSC Nitrogen factors sub committee and working group to be acceptable for the purposes of this study.

Sampling was carried out using the methods detailed in the UK block trials for stages 9 and 13, (figure1).

Table 2. Details of Imported block samples obtained

Country of processing	Single or double frozen	Fishing ground	Species	Capture dates for spent fish (+/- 1wk)	Capture dates for non spent fish	Number of blocks sourced / Factory ID codes / date of catch			
						Fillet Block		Mince block	
						Spent	Non spent	Spent	Non spent
Denmark	Double	Barents	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec	3/ AUT 1121/ 3 May – 6 June 02			
Poland	Single	Baltic	Gadus morhua	Mid August	Mid Nov-Mid March	10/ ?/ 18 Oct 01			
Poland	Single	Baltic	Gadus morhua	Mid August	Mid Nov-Mid March	10 / PL 32611801/ 25 April 01			
Poland	Double	Barents	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec			5/ 32611801/ 1 – 30 June 02	
Poland	Single	Baltic	Gadus morhua	Mid August	Mid Nov-Mid March	5/ 32611801/ 5 – 12 Sept			
Iceland	Single	Icelandic	Gadus morhua	Mid May	Mid Aug-Mid Dec	10/ IS61610/ 11 May 01			
Iceland	Single	Icelandic	Gadus morhua	Mid May	Mid Aug-Mid Dec			2/ IS01709 (PL44)/ 23 June 02	
Iceland	Single	Icelandic	Gadus morhua	Mid May	Mid Aug-Mid Dec			5/ IS01449/ July/August	
Iceland	Single	Icelandic	Gadus morhua	Mid May	Mid Aug-Mid Dec				5/ IS01607/ 8 – 10 August
Norway	Single	Norwegian	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec	5/ ?/ ?			

Key:
? = not known

Table 2 cont.

Country of processing	Single or double frozen	Fishing ground	Species	Capture dates for spent fish (+/- 1wk)	Capture dates for non spent fish	Number of blocks sourced/Factory ID codes/date of catch			
						Fillet Block		Mince block	
						Spent	Non spent	Spent	Non spent
Norway	Single	Norwegian	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec			3/ F162/ June 02	
Norway	Single	Norwegian	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec			5/ F352/ April - May	
Norway	Single	Norwegian	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec	5/ F260/?			
China	Double	Barents	Gadus morhua	1st wk May	1st wk Aug-1st wk Dec	40/ EEC2100/02175/ 14 Feb 01			
China	Double	Bering	Gadus macrocephalus	Mid March	Mid June-Mid Oct		10/EEC 2100/02175/ 15 July 00		
Russia	Double	Barents	Gadus morhua			5/ 48F/ ?			
Lithuania	Double	Baltic	Gadus morhua	Mid August	Mid Nov-Mid March	3/ LT55-29/ 1-8 May			

Key:
? = not known

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2.4 Statistical methodology

The trial was set up as a balanced factorial design with factors for seasons, ground and processing. The data was analysed by least squares and means, presented for each level through the processing chain. The sample size was determined to detect a difference in nitrogen content between the levels of processing of approximately 0.05 (80% probability of detection at the 5% level if such a difference exists).

Analysis of variance models were fitted to each of the chemical components with terms for each of the main components as follows:

Imported Samples

Blocks fillet, mince
Freeze single, double frozen

UK produced blocks

Ground Barents, Norwegian
Season Spent, Non spent

Processing stage Control, fillet ingredient, mince ingredient, commercial fillet block, commercial mince block

In addition the following interactions were tested for inclusion in the model

Ground x Season
Ground x Processing stage
Season x Processing stage

The criterion for including any of these interactions in the model was significance at the 5% level.

3 Results

3.1 UK produced blocks

All proximate analysis results are shown in Appendix III.

Differences between laboratories was tested using least squares analysis. Although the means for the different components were found to be significantly different, for nitrogen the difference was small and considered to be acceptable (Appendix IV).

The original 10 samples of Barents non-spent mince were lost in storage. Sampling was repeated, but on analysis the new results were significantly lower than what would be expected. Hence, the working group decided that these results should be removed from the analysis.

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Table 3 shows the significance levels for the models fitted to the chemical components. Although the fat content differed by season and the ash differed by both processing stage and ground, further investigation of these components revealed differences in the means that were smaller than the tolerance allowed in repeat analysis and hence is not considered significant, only left in the table for completeness.

Table 3. Significance levels of chemical components – UK produced blocks

	Fat	Moisture	Ash	Nitrogen
Ground	ns	ns	**	***
Season	***	ns	ns	***
Processing stage	ns	ns	***	***
Ground x season	ns	ns	ns	***
Ground x processing stage	ns	ns	***	ns
Season x processing stage	ns	ns	***	ns

*** <0.001%
** <0.1%
* <0.5%

Overall means for moisture, fat and ash were 81.5, 0.54 and 1.1 respectively.

Least square means for nitrogen levels by ground and season are shown in Table 4 (pooled control and mince/ fillet fish ingredient). There was no significant difference between the spent samples by ground, however non spent Norwegian samples had a significantly higher nitrogen content than non spent samples from Barents ground.

Table 4: Least square means for nitrogen (% of cod sample) by ground and season

	Barents	Norwegian	Overall
Spent	2.88	2.88	2.88
Non spent	2.68	2.81	2.74
Overall	2.78	2.84	2.81

LSD for any comparison is approx. 0.02 (smallest difference that is significant at the 5% level)

The differences between the processing stages does not change for samples from different grounds or seasons (as indicated by the non significant interactions shown in table 3). For completeness, least square means from the fitted model are shown in table 5 by ground, season and processing stage, however the processing stages effect the samples in a consistent manner regardless of the origin of the sample. Unusually, the spent samples showed a higher nitrogen content than the non spent samples. This suggests that the peak spawning period was delayed resulting in samples being taken just prior to spawning.

Table 5. Nitrogen least squares means by ground and season

	Barents		Norwegian	
	Spent (1^{st} -10^{th} May 2001)	Non spent (Mid August 2003)	Spent (1^{st} week of May 2001)	Non spent (Mid October 2003)
Control	2.93	2.74	2.93	2.86
Fillet ingredient	2.93	2.77	2.93	2.88
Mince ingredient	2.81	2.61	2.81	2.74
Commercial Fillet block	2.85	2.66	2.85	2.78
Commercial Mince block	2.85	2.66	2.85	2.78

Approx. LSD = 0.06

Table 6 shows the least square means by processing stage. As there was no significant interaction between processing stage and ground or season, results have been pooled to give one least square mean per processing stage.

Table 6. Least square means by processing stage (% of cod sample)

	Nitrogen	Fat	Moisture	Ash
Control	2.86	0.51	81.1	1.16
Fillet ingredient	2.88	0.52	81.1	1.18
Mince ingredient	2.74	0.55	81.8	1.09
Comm. Fillet block	2.78	0.52	81.6	1.10
Comm. Mince block	2.78	0.58	81.4	1.09
Approx. LSD	0.03			

3.2 Imported produced blocks

All proximate analysis results are shown in Appendix III. Samples from four catch areas were suspected of having abnormal moisture, nitrogen or ash possibly due to the presence of polyphosphate. Samples from one catch area were not included in the statistical analysis. These are indicated in Appendix III, Table A3-5.

No significant differences were found (at the 5% level) between the proximate analysis components and either fillet / mince or single / double frozen samples.

Least square means are shown in table 8. The means show that fillet blocks have significantly higher nitrogen than the mince blocks and the double frozen samples have a significantly higher nitrogen content than the single frozen samples.

Table 8: Chemical composition as a percentage of the total sample

	Fat	Moisture	Ash	Nitrogen
Fillet	0.49	81.8	1.06	2.74
Mince	0.49	82.0	1.06	2.67
Approx. LSD	0.08	1.12	0.14	0.17
Significance	ns	ns	ns	ns
Single frozen	0.48	82.1	1.09	2.64
Double frozen	0.49	81.7	1.03	2.76
Approx. LSD	0.08	1.12	0.14	0.17
significance	ns	ns	ns	ns

LSD – least significant difference, the smallest difference that would be significant at the 5% level

4 Discussion and conclusions

For UK processed blocks the overall nitrogen content for fillet ingredient and mince ingredient was found to be 2.88% and 2.74% respectively. These values are 8.2% and 5% higher than their respective values in the Code of Practice. This coincides with earlier work on Nephrops where a 5.1% increase in the code value was found after the GMP sampling work [2]. The overall nitrogen content of final commercial fillet and mince blocks was found to be the same at 2.78%.

Nitrogen content was affected by ground, season and processing stage. The overall nitrogen content was found to be higher for Norwegian than for Barents fish. This is supported by the findings of industry [4] and Torry [5] and previous work by the Analytical Methods Committee [6]. The nitrogen content was found to be higher in the spent than the non-spent samples. This is not wholly unexpected as work carried out by Torry [5] with fish straight from the sea showed that although the mean nitrogen content changes slightly during the year the variation in individual fish is great ranging from less than 2.5% to almost 3% at any given point in the year. Earlier work by Torry [5] and Public Analysts [6] derived mean nitrogen contents of 2.9%and 2.85% respectively for fish from the sea. The controls (2.93% – 2.74%) in this work compare favourably, but cannot be compared directly as they have undergone freezing. These results can also be compared with a similar trial carried out by Ross Foods [4] in the same company where a mean of 2.82% and 2.96% was found for dry filleted Baltic and Icelandic fish control, respectively.

Processing had a significant effect on nitrogen content; regardless of ground and season the % nitrogen followed a consistent pattern during the processing stages. The conversion of control to fillet ingredient resulted in no change or an increase in nitrogen whilst the conversion of fillet ingredient to final block resulted in a decrease

in nitrogen, as a result of protein being lost during pressing and freezing.
Mince block production shows a different pattern. The conversion of control to mince ingredient resulted in a decrease in nitrogen content, whilst the conversion of mince ingredient to the final block resulted in an increase in nitrogen content. This may be due to mincing damaging the cells, allowing more water than protein to be lost during pressing and freezing.

For imported commercial blocks the overall nitrogen for fillet and mince blocks was found to be 2.74% and 2.67% respectively.

Single frozen blocks had a lower nitrogen than double frozen blocks at 2.64% and 2.76% respectively.

5 References

1. **Code of Practice on the Declaration of Fish Content in Fish Products.** (Report of a Working Group on Fish Content Determination) drawn up by representatives of the UK Association of Frozen Foods Producers, the British Frozen Food Federation, the British Retail Consortium, the British Hospitality Association, the Sea Fish Industry Authority, LACOTS and the Association of Public Analysts. (March 1998).

2 **Nitrogen factor for *Nephrops norvegicus*** (scampi). Report by the Analytic Methods Committee. Analyst, 2000, 125, p 347-51.

3. **Spawning and Life History Information for North Atlantic Cod Stocks 1994.** ICES Co-operative Research Report No. 205:

4. **The effect of processing on the analytical fish content of the MC 908 (80: 10: 10) Addback blocks / The effect of processing on the analytical fish content of fish raw-material blocks (Second Survey)**
S. Lamming Ross Foods Ltd departmental memorandum (restricted circulation) November 1985 - May 1986

5. **Nitrogen content of seven British commercial species of fish**
R. McLay, the F. Howgate and J. Morrison, Torry Research Station. J. Assoc., Publ, Analysts, 1986 p 131 - 139

6. **Nitrogen Factor for Cod Flesh**
Report prepared by the Fish Products Sub-Committee. Reprinted from the analyst,, August 1966, volume 91, No. 1085, pp. 540 – 542

Appendix I

Analytical Methodology and Laboratories

Appendix I

1. Analytical Methodology and laboratories

The importance of this work demanded that all analytical methods used were recognised and validated, and that sample analysis assigned to experienced analysts.

The participating laboratories are shown in Table A2. All samples will be analysed (duplicate determinations as a minimum) for fat, moisture, ash and nitrogen, using methods and standards agreed by the Nitrogen Factors Sub-Committee of the AMC. The chosen methods for the proximate analysis of prepared fish samples are listed in Table A3. Full details of the analytical requirements are given in Appendix I.

Table A1-1. Nominated laboratories for sample analysis

1	Bristol Scientific Services
2	LGC Teddington
3	Dundee Scientific Services
4	Unilever Research, Colworth Laboratory
5	Young's Bluecrest Seafood Ltd

Table A1-2. Methods for the proximate analysis of cod samples

Parameter	British Standard BS4401	Tolerance Value*
Fat	Part 4: 1970 (1986)	0.5
Moisture	Part 3: 1970 (1986)	1.0
Ash	Part 1: 1980 (1990)	0.1
Nitrogen	Part 2: 1980 (1990)	0.1

*The maximum tolerated difference between the results of two determinations carried out in the same laboratory for a particular parameter, expressed as an absolute percentage.

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1.1 Reporting of method

As undertaken in the previous studies, each participating laboratory should supply to the Nitrogen Factors Sub-Committee a written statement including the following information on analytical methodology.

a) Method of analysis employed for each and every parameter. If the method is a British Standard (BS) or other well documented method, a literature reference will suffice. If the method is a modification of a BS or other documented method or is a quite different method then full details of that modification or alternative method should be supplied.

b) If any method quoted is not a complete BS method, evidence should be supplied that results obtained by the method are equivalent to those obtainable by the full BS method. Evidence that modified or alternative methods are equivalent to BS methods may be extracted from a laboratory's existing records or may take the form of an internal ad hoc exercise for those parameters for which information is not already available. Modified BS methods or alternative methods accepted under the pig, beef or sheep composition studies will also be acceptable for the frozen cod block composition trial. Modifications of BS methods as regards sample preparation are excluded from this required evidence.

c) An outline of analytical quality assurance (AQA) procedures employed for each method.

1.2 Quality Control Procedures

All laboratories are required to carry out quality control procedures. This must include analysis of the prescribed reference material in each batch of samples analysed. The reference material prescribed on this occasion will be a tinned mackerel paste standard (200g) obtained from the LGC.

2. Results

2.1 Criteria of Acceptability

Having carried out one pair of determinations for each parameter, the results should be inspected using the following criteria. Results for each sample that satisfy all criteria may be reported without further analytical work.

a) All individual results must be acceptable to the analyst, that is no figure is absurd or an analytical rogue.

b) The difference between each result in a pair of duplicates must not exceed the appropriate tolerance value listed in the table 3.

c) The sum of the mean values for % fat, % moisture, % ash and % protein (N x 6.25) must fall within the range 98 to 102.

2.2 Rejection of results

If, for any sample, one or more of the criteria in paragraph 2.1, are not satisfied after the first set of determinations, then the following procedure should be adopted.

a) If the analyst identifies any individual result as a rogue he should reject that particular result (but see paragraph 2.4 (c) for directions on reporting). This rejection requirement also applies to individual results obtained in subsequent pairs of determinations. However the duplicate determination of a pair, if that is not also a rogue, should be retained. A fresh pair of determinations for the relevant parameter must then be made. The calculation of the mean result under these circumstances is given in paragraphs 2.3 (b) and 2.3 (c).

b) If, for any parameter, the tolerance value is exceeded in the first pair of duplicates then a second pair of determinations must be made. Except in the rare circumstances of more than one individual result being rejected as a rogue or difficulty being experienced with satisfying the summation criterion, not more than two pairs of determinations are required. The calculation of the mean result where two, or more, pairs of determinations have been made is given in paragraphs 2.3 (d) and 2.3 (e).

c) If the mean values fail the summation requirement, then further pairs of determinations of suspect parameters must be carried until, using revised mean values calculated in accordance with paragraphs 2.3 (d) to 2.3 (e), the summation criterion is satisfied. Not more than three pairs of determinations are required.

2.3. Treatment of results

Mean results for each parameter and set of circumstances are to be calculated as follows.

a) The mean result of a first pair of duplicates for any parameter that satisfies the appropriate tolerance value is the arithmetic mean of those two individual results.

b) Where for any parameter an individual result has been rejected as a rogue but the second or subsequent pair of determinations satisfies the tolerance value, the mean result is either the arithmetic mean of the three or more acceptable individual results if all those individual results taken together satisfy the tolerance value or, if the first alternative is not possible, the arithmetic mean of the second or subsequent pair of determinations that did satisfy the tolerance value.

c) Where for any parameter an individual result has been rejected as a rogue and the second or subsequent pair of determinations do not satisfy the tolerance value, the mean result is the arithmetic mean of all three or more acceptable individual results.

d) Where for any parameter no individual result has been rejected as a rogue and the second pair of determinations satisfies the tolerance value, the mean result is either the arithmetic mean of any three individual results if those individual results taken together satisfy the tolerance value or, if the first alternative is not possible, the arithmetic mean of the second pair of determinations that did satisfy the tolerance value.

e) Where for any parameter no individual result has been rejected as a rogue and, like the first pair, the second pair of determinations does not satisfy the tolerance value, the mean result is the arithmetic mean of all four individual results.

2.4. Reporting

Individual and mean results are to be reported on the standard white form (specimen attached as Appendix II) and separate forms must be prepared for each sample.

Units are to be per cent by weight. Significant figures for the purpose of reporting by laboratories are as follows: moisture, fat, protein and summation figures to one decimal place; nitrogen and ash to two decimal places.

Information identifying the laboratory (see 2.4 (e) below), the sample code and dates when the analytical work were commenced and completed should be entered at the head of the form.

Individual analytical results are to be entered in the appropriate boxes, sub-headed 1, 2, 3, for each parameter; however where any result had been rejected as a rogue (paragraph 2.2 (a)) then the code '-1' should be entered.

Mean results, as calculated in accordance with paragraph 2.3, are to be entered in the appropriate boxes under the heading 'Final Lab Figure'. Figures for protein (mean % nitrogen x 6.25) and total (summation figure) are to be entered in the appropriate boxes at the foot of the form.

Laboratory reference number/codes to be used in the trial and report forms are as follows:

Bristol Scientific Services
Laboratory of the Government Chemist
Dundee Scientific Services
Unilever Research, Colworth Laboratory
Young's Bluecrest Seafoods

In addition to the analytical results, indicator codes in the columns marked 'I' must be entered according to the following directions.

'1' alongside all individual results which have been included in the final calculation of the mean result.

'0' to be entered alongside all results which are to be excluded from the final calculation of the overall result.

Table A1-3

Chemical Composition Trials
Chemical Analysis Recording Sheet

Frozen Cod *(Gadus morhua)* Blocks

	Lab	Sample code	Date commenced	Date completed

% Determinations	Final lab figure	Duplicate							
		Pair 1				Pair 2			
		1	I	2	I	3	I	4	I
Fat									
Moisture									
Ash									
Nitrogen									

Total = moisture + fat + protein + ash
Moisture, fat and total to one decimal place
Nitrogen, ash and salt to two decimal place

Protein | Total

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Appendix II

Seasonality

Appendix II

Seasonality

For trials using spent fish, it was essential to obtain blocks with the highest practically possible proportion of spent fish. As fish generally remain in spent condition for approximately 2 months after spawning, it was proposed to obtain samples of fish blocks made from spent fish caught approximately 1 month after the end of the peak spawning season for each ground. The International Council for exploration of the Seas (ICES) where contacted to get the most up-to-date information on the peak-spawning season for cod from both grounds (Table A1).

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Due to the potential for variation in peak spawning season, evidence from the supplier in the form of visual inspection and/or changes in filleting yield was used where possible in conjunction with peak spawning information.

Table A2-1. Peak spawning seasons and capture date of samples obtained

Fishing ground	Peak spawning season	Actual or capture date of samples obtained
Barents Sea	1st week of April*	1st – 10th May 2001
Norwegian Waters	March – April	1st – 7th May 2001

*From ICES report No. 205 on cod from Barents Sea spawning near the Norwegian coast

For trials using non spent fish, the raw material blocks were collected at least 4 months before or after the peak spawning period for the given capture area.

Appendix III

Results

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Table A3-1

Proximate analysis results - Barents cod (spent season)

	Lab Code	% Fat	% Moisture	% Ash	% Nitrogen
Control (Air defrosted)	X	0.4, 0.5, 0.4, 0.2	81.6, 80.6, 81.4, 80.9	1.1, 1.1, 1.1, 1.1	2.79, 2.93, 2.79, 3.06
	V	0.8, 0.8, 0.7, 0.6	80.2, 80.8, 80.3, 80.8	1.10, 1.13, 1.14, 1.11	2.95, 3.01, 2.90, 2.84
	L	0.6, 0.7, 0.9, 0.5	80.6, 79.2, 78.6, 80.9	1.06, 1.06, 1.08, 1.07	2.89, 2.89, 3.04, 2.87
	M	0.5, 0.4, 0.3, 0.3	81.0, 81.5, 81.6, 81.0	1.12, 1.11, 1.10, 1.14	3.06, 2.93, 2.89, 3.02
	T	0.7, 0.6, 0.7, 0.7	81.9, 81.2, 80.6, 80.3	1.14, 1.14, 1.15, 1.14	2.76, 2.83, 2.84, 2.96
Hand & machine filleted fillet ingredient	X	0.3, 0.4, 0.4, 0.5	81.6, 80.4, 80.9, 81.2	1.1, 1.2, 1.0, 1.0	2.98, 2.83, 2.94, 3.00
	V	1.0, 0.9, 1.2, 0.9	80.0, 80.8, 80.3, 80.5	1.25, 1.21, 1.10, 1.14	3.00, 2.74, 2.88, 2.95
	L	0.9, 1.0, 0.9, 0.5	79.6, 78.3, 78.7, 80.0	1.16, 1.16, 0.95, 1.10	2.98, 3.01, 3.05, 3.06
	M	0.3, 0.3, 0.4, 0.4	80.7, 80.7, 80.4, 81.0	1.24, 1.22, 1.15, 1.11	3.00, 2.98, 3.00, 3.00
	T	0.7, 0.6, 0.6, 0.7	80.1, 81.2, 81.7, 81.1	1.12, 1.14, 1.08, 1.12	2.97, 2.88, 2.78, 2.80
Hand & machine filleted mince ingredient	X	0.6, 0.5, 0.6, 0.5	80.9, 81.2, 80.6, 80.8	1.0, 1.1, 1.0, 1.0	2.80, 2.77, 2.92, 3.01
	V	0.9, 1.0, 0.8, 0.9	79.6, 80.6, 81.2, 80.7	1.03, 1.07, 1.09, 1.03	2.99, 2.85, 2.84, 2.74
	L	0.6, 0.7, 0.7, 0.4	81.1, 81.3, 80.4, 81.7	1.01, 0.98, 1.06, 1.09	2.77, 2.64, 3.13, 2.69
	M	0.5, 0.6, 0.5, 0.4	80.7, 81.5, 82.3, 81.7	1.05, 1.11, 1.09, 1.10	2.90, 2.82, 2.78, 2.93
	T	0.7, 0.4, 0.4, 0.4	81.1, 83.1, 82.1, 83.1	1.08, 1.10, 1.09, 1.10	2.76, 2.62, 2.62, 2.62
Commercial fillet block	X	0.5, 0.5, 0.3, 0.6	80.7, 81.7, 81.4, 81.0	1.1, 1.1, 1.1, 1.1	2.92, 2.72, 3.01, 3.03
	V	0.8, 0.6, 0.7, 0.8	81.3, 81.5, 81.8, 79.7	1.09, 1.10, 1.11, 1.12	2.74, 2.95, 2.70, 3.21
	L	0.6, 0.7, 0.5, 0.6	80.0, 80.2, 81.1, 80.0	1.06, 1.11, 1.05, 1.17	2.60, 3.11, 2.97, 2.96
	M	0.3, 0.3, 0.3, 0.3	81.1, 83.2, 81.4, 81.0	1.11, 1.07, 1.07, 1.12	2.92, 2.59, 2.91, 2.92
	T	0.5, 0.6, 0.4, 0.5	80.3, 80.7, 81.8, 81.3	1.12, 1.11, 1.12, 1.12	2.96, 2.90, 2.82, 2.93
Commercial mince block	X	0.5, 0.5, 0.7, 0.7	80.7, 81.2, 81.3, 81.4	1.0, 1.0, 1.1, 1.1	2.92, 2.91, 2.84, 2.82
	V	1.0, 1.0, 0.8, 0.9	80.9, 81.1, 81.3, 80.0	1.08, 1.06, 1.09, 1.09	2.83, 2.80, 2.73, 3.01
	L	0.9, 0.9, 0.6, 0.6	80.5, 80.3, 80.7, 79.9	1.05, 1.08, 1.08, 1.11	2.75, 2.91, 2.70, 2.80
	M	0.3, 0.3, 0.4, 0.4	81.1, 81.3, 81.5, 80.8	1.09, 1.09, 1.14, 1.11	2.83, 2.87, 2.89, 2.97
	T	0.7, 0.5, 0.7, 0.5	81.1, 80.6, 81.9, 82.0	1.09, 1.08, 1.08, 1.16	2.76, 2.81, 2.74, 2.64

Notes: X - Youngs Bluecrest Analytic lab, V - Bristol Sci. Services, L - LGC Teddington,
M - Unilever Research Lab, T - Dundee Sci Services

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Table A3-2

Proximate analysis results - Barents cod (non-spent season)

	Lab Code	% Fat	% Moisture	% Ash	% Nitrogen
Control (Air defrosted)	X	0.2, 0.2, 0.1, 0.1	82.3, 82.8, 82.1, 82.5	1.2, 1.1, 1.2, 1.2	2.69, 2.73, 2.66, 2.72
	V	0.7, 0.8, 0.5, 0.8	82.6, 80.4, 83.4, 82.1	1.15, 1.16, 1.13, 1.12	2.75, 3.09, 2.71, 2.82
	L	0.48, 0.45, 0.37, 0.46	83.9, 81.2, 80.4, 81.5	1.14, 1.17, 1.21, 1.12	2.53, 2.94, 3.05, 2.76
	M	0.2, 0.2, 0.3, 0.2	82.3, 82.5, 81.6, 82.6	1.16, 1.15, 1.16, 1.18	2.75, 2.70, 2.86, 2.67
	T	0.5, 0.6, 0.5, 0.5	82.0, 81.2, 82.0, 81.6	1.12, 1.16, 1.16, 1.17	2.65, 2.93, 2.89, 2.86
Hand & machine filleted fillet ingredient	X	0.3, 0.2, 0.3, 0.3	82.0, 81.4, 82.2, 82.4	1.1, 1.1, 1.1, 1.1	2.79, 2.86, 2.74, 2.72
	V	0.6, 0.6, 0.7, 0.7	82.4, 82.5, 82.5, 82.8	1.09, 1.04, 1.07, 1.09	2.75, 2.67, 2.70, 2.79
	L	0.4, 0.44, 0.39, 0.51	81.3, 81.3, 81.4, 83.4	1.08, 1.15, 1.08, 1.01	2.89, 2.97, 2.70, 2.50
	M	0.2, 0.2, 0.4, 0.3	82.1, 81.6, 82.4, 83.0	1.09, 1.10, 1.09, 1.12	2.79, 2.85, 2.75, 2.63
	T	0.5, 0.5, 0.6, 0.5	82.0, 81.7, 82.0, 81.7	1.11, 1.11, 1.11, 1.10	2.64, 2.65, 2.65, 2.67
Hand & machine filleted mince ingredient	X	0.2, 0.2, 0.4, 0.3	84.1, 83.7, 84.1, 84.2	1.1, 1.1, 1.0, 1.0	**2.46, 2.38, 2.36, 2.38****
	V	0.7, 0.7, 0.6, 0.7	82.3, 83.9, 82.9, 83.1	1.03, 1.03, 0.98, 0.94	**2.76, 2.51, 2.31, 2.64**
	L	0.42, 0.36, 0.37, 0.35	84.1, 84.2, 83.5, 84.6	1.04, 1.05, 0.89, 1.05	**2.42, 2.18, 2.42, 2.38**
	M	0.2, 0.2, 0.3, 0.2	84.0, 84.2, 85.1, 84.9	1.04, 1.04, 1.01, 1.00	**2.36, 2.35, 2.25, 2.33**
	T	0.5, 0.6, 0.5, 0.5	83.1, 83.4, 84.0, 83.9	1.04, 1.04, 0.98, 0.99	**2.43, 2.41, 2.24, 2.22**
Commercial fillet block	X	0.2. 0.3, 0.5, 0.5	83.1, 82.3, 81.6, 82.4	1.2, 1.2, 1.1, 1.1	2.56, 2.67, 2.73, 2.63
	V	0.6, 0.6, 0.7, 0.6	82.1, 82.3, 82.7, 82.6	1.18, 1.12, 1.10, 1.09	2.64, 2.68, 2.56, 2.77
	L	0.69, 0.49, 0.48, 0.7	83.3, 82.7, 82.4, 82.1	1.21, 0.71, 1.10, 1.04	2.64, 2.70, 2.81, 2.54
	M	0.2, 0.1, 0.2, 0.2	82.9, 82.7, 82.7, 82.8	1.16, 1.22, 1.10, 1.10	2.65, 2.67, 2.70, 2.72
	T	0.8, 0.8, 0.8, 0.77	82.4, 82.0, 82.8, 83.7	1.21, 1.18, 1.11, 1.08	2.41, 2.74, 2.52, 2.34
Commercial mince block	X	0.3, 0.2, 0.3, 0.5	83.0, 82.4, 83.5, 83.0	1.1, 1.1, 1.1, 1.1	2.69, 2.66, 2.52, 2.73
	V	0.6, 0.6, 0.6, 0.6	82.6, 83.2, 83.4, 82.3	1.13, 1.15, 1.15, 1.26	2.60, 2.45, 2.52, 2.68
	L	0.76, 0.56, 0.58, 0.73	83.2, 81.4, 82.2, 81.5	1.13, 1.14, 1.12, 1.08	2.61, 2.77, 2.59, 2.90
	M	0.1, 0.2, 0.2, 0.2	83.1, 82.9, 82.5, 83.2	1.14, 1.13, 1.10, 1.10	2.60, 2.59, 2.66, 2.59
	T	0.6, 0.5, 0.6, 0.5	81.5, 82.7, 82.4, 82.4	1.15, 1.14, 1.13, 1.10	2.79, 2.43, 2.58, 2.39

Notes: X - Youngs Bluecrest Analytic lab, V - Bristol Sci. Services, L - LGC Teddington,
M - Unilever Research Lab, T - Dundee Sci Services **** Data block removed from statistical analysis**

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Table A3-3

Proximate analysis results - Norwegian cod (spent season)

	Lab Code	% Fat	% Moisture	% Ash	% Nitrogen
Control (Air defrosted)	X	0.4, 0.7, 0.6, 0.5	81.5, 80.5, 80.8, 80.3	1.2, 1.2, 1.2, 1.2	2.75, 2.84, 2.89, 2.86
	V	0.7, 0.6, 0.9, 0.8	80.9, 79.7, 81.2, 79.5	1.27, 1.25, 1.19, 1.30	2.79, 2.92, 2.95, 2.86
	L	0.7, 0.6, 0.6, 0.5	79.9, 79.8, 80.8, 81.1	1.21, 1.23, 1.25, 1.29	2.99, 3.10, 2.86, 2.74
	M	0.3, 0.4, 0.4, 0.3	81.2, 80.3, 80.0, 80.9	1.27, 1.31, 1.30, 1.28	2.84, 3.01, 3.04, 3.05
	T	0.7, 0.6, 0.8, 0.8	80.9, 80.8, 80.4, 79.8	1.34, 1.25, 1.27, 1.34	3.00, 2.80, 2.87, 3.02
Hand filleted fillet ingredient	X	0.6, 0.4, 0.2, 0.3	81.2, 81.5, 80.1, 80.8	1.1, 1.1, 1.1, 1.1	2.82, 2.90, 3.05, 2.91
	V	0.7, 0.9, 0.7, 0.8	80.8, 80.6, 80.9, 80.3	1.14, 1.11, 1.13, 1.14	3.08, 2.95, 2.77, 3.12
	L	0.6, 0.5, 0.5, 0.4	80.7, 79.1, 79.4, 80.1	1.12, 1.07, 1.08, 1.07	2.82, 3.00, 3.09, 3.02
	M	0.6, 0.4, 0.5, 0.4	80.5, 80.5, 80.6, 80.7	1.11, 1.12, 1.20, 1.13	3.11, 3.07, 2.98, 3.06
	T	0.7, 0.6, 0.6, 0.7	80.1, 81.2, 81.7, 81.1	1.12, 1.14, 1.08, 1.12	2.97, 2.88, 2.78, 2.80
Hand filleted mince ingredient	X	0.6, 0.6, 0.4, 0.6	81.7, 81.6, 81.8, 81.0	1.0, 1.1, 1.0, 1.0	2.81, 2.68, 2.90, 2.87
	V	1.0, 0.9, 1.1, 1.0	81.3, 80.3, 80.6, 81.9	1.05, 1.04, 1.07, 1.07	2.65, 2.96, 2.93, 2.77
	L	0.5, 0.5, 0.4, 0.7	81.8, 81.6, 81.6, 81.9	1.06, 1.01, 1.06, 1.09	2.79, 2.91, 2.88, 2.63
	M	0.4, 0.4, 0.3, 0.2	81.7, 81.9, 81.7, 82.4	1.12, 1.13, 1.12, 1.11	2.79, 2.75, 2.81, 2.72
	T	0.7, 0.7, 0.8, 0.7	81.8, 81.7, 81.0, 81.6	1.11, 1.11, 1.10, 1.12	2.72, 2.79, 2.76, 2.69
Commercial fillet block	X	0.1, 0.6, 0.4, 0.4	81.2, 83.9, 82.6, 81.4	1.1, 1.0, 1.0, 1.0	2.90, 2.45, 2.64, 2.74
	V	0.9, 0.7, 0.8, 0.8	80.8, 81.9, 81.8, 81.2	1.10, 1.12, 1.10, 1.12	2.87, 2.86, 2.75, 2.79
	L	0.7, 0.6, 0.6, 0.8	81.4, 80.9, 81.4, 80.6	1.07, 1.10, 1.10, 1.07	2.86, 2.84, 2.58, 3.00
	M	0.4, 0.3, 0.3, 0.4	81.3, 81.4, 80.7, 80.6	1.10, 1.10, 1.09, 1.10	2.94, 2.91, 2.97, 3.04
	T	0.7, 0.6, 0.6, 0.7	80.6, 80.6, 81.2, 80.4	1.08, 1.11, 1.09, 1.10	2.82, 2.78, 2.62, 3.03
Commercial mince block	X	0.7, 0.5. 0.5, 0.6	80.9, 80.8, 81.3, 81.2	1.0, 1.0, 1.0, 1.1	2.88, 3.03, 2.89, 2.86
	V	0.9, 0.9, 0.9, 0.8	81.7, 80.9, 80.7, 81.4	1.09, 1.07, 1.08, 1.07	2.85, 2.85, 2.90, 2.75
	L	0.9, 1.0, 0.9, 1.0	80.8, 79.4, 79.6, 80.4	1.10, 1.04, 1.02, 1.02	2.87, 2.97, 2.98, 2.92
	M	0.4, 0.4, 0.3, 0.3	80.8, 80.8, 81.1, 80.5	1.09, 1.09, 1.10, 1.07	2.90, 2.90, 2.88, 3.00
	T	0.7, 0.9, 0.9, 0.8	81.4, 80.5, 79.7, 81.4	1.06, 1.10, 1.08, 1.04	2.71, 3.09, 3.02, 2.85

Notes: X - Youngs Bluecrest Analytic lab, V - Bristol Sci. Services, L - LGC Teddington,
M - Unilever Research Lab, T - Dundee Sci Services

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Table A3-4

Proximate analysis results - Norwegian cod (non-spent season)

	Lab Code	% Fat	% Moisture	% Ash	% Nitrogen
Control (Air defrosted)	X	0.1, 0.4, 0.4, 0.2	81.3, 81.5, 81.2, 80.9	1.2, 1.2, 1.1, 1.2	2.88, 2.90, 2.73, 2.84
	V	0.8, 0.6, 0.5, 0.7	80.7, 83.4, 83.3, 81.3	1.17, 1.16, 1.01, 1.18	2.98, 2.67, 2.70, 2.91
	L	0.64, 0.57, 0.64, 0.69	80.3, 83.4, 80.0, 81.4	1.12, 1.06, 1.04, 1.05	2.99, 2.63, 2.83, 2.74
	M	0.2, 0.2, 0.1, 0.2	81.5, 80.7, 81.7, 82.5	1.17, 1.13, 1.13, 1.07	2.90, 2.97, 2.84, 2.72
	T	0.6, 0.6, 0.6, 0.5	81.0, 81.1, 80.6, 81.1	1.16, 1.09, 1.14, 1.20	2.80, 2.66, 2.93, 2.72
Hand filleted fillet ingredient	X	0.3, 0.2, 0.3, 0.2	81.4, 81.3, 81.8, 81.4	1.2, 1.2, 1.2, 1.2	2.91, 2.96, 2.77, 2.80
	V	0.7, 0.7, 0.8, 0.7	81.9, 82.2, 81.7, 81.7	1.16, 1.08, 1.10, 1.10	2.87, 2.79, 2.89, 2.76
	L	0.49, 0.4,2 0.41, 0.6	78.9, 80.3, 81.4, 80.0	1.13, 1.03, 1.05, 1.13	3.16, 3.14, 2.69, 2.98
	M	0.2, 0.3, .03, 0.4	82.2, 81.0, 81.9, 80.4	1.13, 1.13, 1.16, 1.17	2.78, 2.92, 2.86, 3.09
	T	0.7, 0.6, 0.6, 0.5	80.3, 80.7, 8.04, 81.4	1.15, 1.14, 1.15, 1.13	2.83, 2.94, 2.83, 2.68
Hand filleted mince ingredient	X	0.2, 0.4, 0.4, 0.6	81.7, 81.5, 81.2, 81.7	1.2, 1.2, 1.1, 1.1	2.81, 2.76, 2.85, 2.76
	V	0.8, 0.4, 0.8, 0.9	82.4, 82.4, 82.6, 82.5	1.12, 1.13, 1.07, 1.11	2.74, 2.60, 2.80, 2.81
	L	0.66, 0.42, 0.62, 0.78	80.9, 82.1, 81.5, 80.8,	1.14, 0.89, 1.12, 1.07	2.64, 2.75, 2.90, 2.93
	M	0.2, 0.2, 0.2, 0.3	82.7, 82.6, 82.5, 82.4	1.14, 1.16, 1.17, 1.15	2.67, 2.67, 2.70, 2.73
	T	0.6, 0.7, 0.6, 0.7	81.4, 81.0, 81.5, 80.9	1.14, 1.16, 1.15, 1.14	2.79, 2.82, 2.57, 2.93
Commercial fillet block	X	0.3, 0.4, 0.4, 0.1	83.2, 82.0, 81.7, 81.9	1.1, 1.1, 1.1, 1.1	2.73, 2.74, 2.94, 2.67
	V	0.8, 0.8, 0.7, 0.8	81.3, 82.1, 81.3, 81.7	1.13, 1.11, 1.10, 1.13	2.81, 2.81, 2.70, 2.69
	L	0.64, 0.52, 0.52, 0.58	82.0, 81.0, 80.2, 81.1	1.01, 1.13, 1.04, 1.08	2.56, 2.65, 2.99, 2.89
	M	0.2, 0.2, 0.2, 0.2	82.1, 82.1, 81.5, 82.5	1.09, 1.10, 1.14, 1.13	2.79, 2.79, 2.89, 2.80
	T	0.5, 0.9, 0.5, 0.5	82.2, 80.9, 80.5, 80.9	1.11, 1.13, 1.13, 1.13	2.74, 2.84, 3.02, 2.71
Commercial mince block	X	0.6, 0.1, 0.3, 0.4	81.8, 82.4, 81.8, 82.6	1.1, 1.1, 1.0, 1.1	2.72, 2.82, 2.80, 2.79
	V	0.7, 1.0, 0.5, 0.7	82.3, 81.8, 82.2, 81.9	1.09, 1.11, 1.14, 1.14	2.71, 2.72, 2.63, 2.74
	L	0.64, 0.51, 0.67, 0.68	81.0, 80.9, 79.3, 80.8	1.09, 0.97, 1.12, 0.95	2.65, 2.71, 3.35, 3.05
	M	0.2, 0.2, 0.2, 0.2	82.0, 81.9, 82.1, 82.5	1.11, 1.13, 1.12, 1.14	2.82, 2.79, 2.79, 2.75
	T	0.6, 0.6, 0.6, 0.6	80.6, 80.6, 81.7, 80.8	1.14, 1.14, 1.14, 1.13	2.68, 2.66, 2.67, 2.67

Notes: X - Youngs Bluecrest Analytic lab, V - Bristol Sci. Services, L - LGC Teddington,
M - Unilever Research Lab, T - Dundee Sci Services

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Table A3-5

Poland (Baltic Sea)	Single	Fillet	0.2	0.5	0.65	0.2	0.4	83.3	82.5	82.5	83.2	82.1	1.1	1.1	1.04	1.14	1.10	2.45	2.7	2.53	2.6
Poland (Barents Sea)	Double	Mince	0.3	0.7	0.74	0.2	0.7	83.2	81.6	82.2	82.9	82.5	1.1	1.1	1.03	1.08	1.08	2.62	2.72	2.73	2.5
Poland (Baltic Sea)	Single	Fillet	0.4	0.5	0.73	0.2	0.4	84.0	82.6	85.3	83.4	82.9	1.2	1.16	1.09	1.18	1.18	2.36	2.55	2.30	2.5
Iceland (Icelandic Waters)	Single	Fillet	0.7	0.6	0.60	0.2	0.4	81.9	81.1	81.4	82.7	81.7	1.0	1.01	0.98	1.00	1.00	2.57	2.89	2.73	2.7
Iceland (Icelandic Waters)	Single	Mince	0.6	0.5	0.31	0.2	0.5	83.9	83.4	83.0	83.4	82.3	1.0	1.06	1.00	1.01	1.00	2.46	2.71	2.56	2.4
Iceland (Icelandic Waters)* †	Single	Mince	0.0	0.6	0.52	0.2	0.4	87.2	85.1	85.1	86.5	86.0	1.2	1.14	1.09	1.19	1.14	2.24	2.03	2.23	1.9
Iceland (Icelandic Waters)	Single	Mince	0.0	0.6	0.62	0.2	0.6	81.9	80.6	81.7	81.7	80.2	1.0	0.89	0.89	0.94	0.90	2.68	2.96	2.54	2.7
Norway (Norwegian)	Single	Fillet	0.3	0.7	0.54	0.3	0.6	81.6	79.5	80.1	79.7	79.6	1.1	1.1	0.96	1.01	1.08	2.89	3.09	3.21	3.1
Norway (Norwegian)*	Single	Mince	0.4	0.7	0.77	0.2	0.6	81.4	81.8	79.5	81.5	79.5	1.1	1.07	1.02	1.00	1.04	2.41	2.98	3.03	2.7
Norway (Norwegian)*	Single	Mince	0.4	0.7	0.74	0.2	0.6	82.4	82.9	83.9	83.1	82.1	1.4	1.26	1.27	1.36	1.31	2.39	2.38	2.37	2.4
Norway (Norwegian)	Single	Fillet	0.5	0.9	0.76	0.2	0.6	83.0	82.2	81.0	82.3	81.2	1.1	1.12	0.96	1.14	1.08	2.61	2.74	2.74	2.6
China (Barents Sea)	Double	Fillet	0.2	0.9	0.76	0.2	0.7	82.1	82.1	81.1	81.3	80.9	0.9	0.94	0.88	0.98	0.96	2.64	2.81	2.96	2.9
China (Bering Sea)	Double	Fillet	0.3	0.8	0.65	0.3	0.7	80.8	80.3	79.5	81.2	79.0	0.8	0.92	0.80	0.88	0.89	2.73	3.17	2.81	2.9
Russia (Barents Sea)	Double	Fillet	0.3	0.7	0.58	0.2	0.5	81.8	82.2	82.2	82.3	81.8	1.0	0.97	0.90	0.97	1.02	2.65	2.88	2.91	2.8
Lithuania (Baltic)	Double	Fillet	0.0	0.5	0.61	0.3	0.5	81.6	82.4	80.6	82.3	81.8	1.0	0.99	1.00	1.01	1.07	2.75	2.61	2.80	2.6

Notes: X = Youngs Bluecrest Analytic lab, V - Bristol Sci. Services, L - LGC Teddington,
M = Unilever Research Lab, T - Dundee Sci Services
* = Samples suspected of having abnormal moisture and ash values
† = Not included in statistical analysis

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Table A3-6

Average proximate analysis results – Imported blocks

Sample	Single/ Double frozen	Fillet/ Mince Block	% Fat	% Moisture	% Ash	% Nitrogen
Denmark (Barents)	Double	Fillet	0.47	82.10	1.31	2.75
Poland (Baltic Sea)	Single	Fillet	0.49	82.60	1.22	2.53
Poland (Baltic Sea)	Single	Fillet	0.39	82.70	1.10	2.58
Poland (Barents Sea)	Double	Mince	0.53	82.50	1.08	2.68
Poland (Baltic Sea)	Single	Fillet	0.45	83.60	1.16	2.42
Iceland (Icelandic Waters)	Single	Fillet	0.50	81.80	1.00	2.73
Iceland (Icelandic Waters)	Single	Mince	0.42	83.20	1.01	2.52
Iceland (Icelandic Waters)	Single	Mince	0.34	86.00	1.15	2.10
Iceland (Icelandic Waters)	Single	Mince	0.40	81.20	0.92	2.78
Norway (Norwegian)	Single	Fillet	0.49	80.10	1.05	3.08
Norway (Norwegian)	Single	Mince	0.53	80.70	1.05	2.81
Norway (Norwegian)	Single	Mince	0.53	82.90	1.32	2.40
Norway (Norwegian)	Single	Fillet	0.59	81.90	1.08	2.61
China (Barents Sea)	Double	Fillet	0.55	81.50	0.93	2.79
China (Bering Sea)	Double	Fillet	0.55	80.20	0.86	2.94
Russia (Barents Sea)	Double	Fillet	0.46	82.10	0.97	2.81
Lithuania (Baltic)	Double	Fillet	0.38	81.70	1.01	2.74

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Appendix IV

Additional Statistical results

Appendix IV Additional Statistical results

To aid in checking the validity of the data used in the main analysis, chemical components were analysed by laboratory. Table A4 shows least square means by laboratory. Although means were significantly different for each component the actual differences are small and there is no reason to suspect any of the data is not representative of the cod sampled

Table A4-1. Least square means by laboratory.

	Fat	Moisture	Ash	Nitrogen
L	0.6	81.0	1.08	2.83
M	0.3	81.8	1.13	2.82
T	0.6	81.4	1.13	2.75
V	0.8	81.6	1.11	2.80
X	0.4	81.7	1.10	2.80
significance	***	**	***	*

*** p<0.001

** <0.1%

* <0.5%

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