Scallop Portion Size Study

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Table of Contents

Appendices

List of tables

Appendix 2 tables

List of figures

Executive Summary

In 2003 the Sea Fish Industry Authority (Seafish) in partnership with the scallop industry commissioned a study to investigate the weight of a scallop portion, in and out of home, in key European markets. The main purpose of the study was to establish some pertinent features of the distribution of the weight of a scallop portion in regions of heavy scallop consumption.

The study was prompted following the recommendation by the European Commission for a lower threshold for the presence of domoic acid, a neurotoxin that leads to Amnesic Shellfish Poisoning (ASP). One of the assumptions underlying this decision was an average portion weight of 250g, based on the estimated average portion weight for mussels. This assumed average weight of 250g was believed within the scallops industry to be considerably higher than the true weight of scallop portions routinely eaten by consumers – both at home and in restaurants. Since this assumption was of critical importance, and with far reaching consequences, the study was undertaken to fill this gap in the evidence base, providing accurate and precise details of scallop portion weights through a scientifically robust study, with proper statistical design, rigorous study conduct, and appropriate statistical analysis and reporting.

This report outlines the background and objectives of this study, the project approach and key findings. Sampling occurred both within the capital cities and in provincial regions of five countries of known high scallop consumption (the UK, France, Italy, Spain and Belgium).

The in-home section of the study recruited up to 250 consumers purchasing scallops from retail outlets for home consumption in each country, with up to ten retail outlets targeted in each of the five countries. The out of home section consisted of visits to 100 out-of-home (usually restaurant) settings in each of the five countries.

Almost 1000 individual scallops were also collected across the five countries for accurate laboratory determination of the weight of the scallops (both adductor muscle and gonad/roe separately). These scallops were randomly selected in batches of ten from a mixture of retail outlets, with roughly equal numbers from each of the five countries.

The study was conducted using pre-specified protocols given to trained field workers. Throughout all stages of the study standardisation of measurements and procedures was insisted upon. All statistical analysis was the subject of a pre-specified statistical analysis plan, agreed in advance by the project group.

The following tables summarise average portion weights overall and across countries for in and out of home scallop consumption.

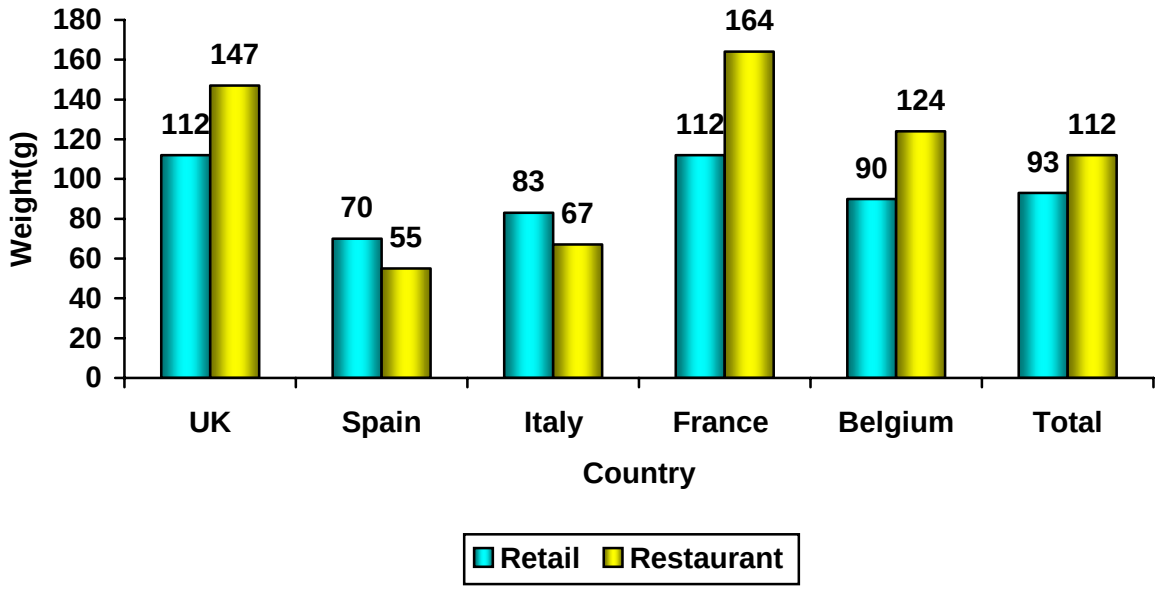
Table 1: Average portion weight for scallop consumption in home (grammes)

Retail	N	Mean	SD	Median	1st percentile	99th percentile
UK	607	112	59	105	21	287
Spain	990	70	57	56	15	354
Italy	745	83	53	68	19	278
France	720	112	55	103	20	271
Belgium	437	90	50	79	21	273
Overall Retail	**3498**	**93**	**55**	**83**	**19**	**292**

Table 2: Average portion weight for scallop consumption out of home (grammes)

Restaurant	N	Mean	SD	Median	1st percentile	99th percentile
UK	5829	147	77	133	26	396
Spain	3868	55	30	49	14	157
Italy	4343	67	40	57	5	201
France	5911	164	59	165	47	301
Belgium	4388	124	57	116	29	280
Overall Restaurant	**23340**	**112**	**54**	**104**	**24**	**267**

Figure 1: Average portion weights across countries



Conclusion

In conclusion, combining the two sources (in home and restaurant) the average weight for a notional scallop portion across the EU is approximately 100g, only 40% of the assumed figure of 250g.

Substantial variability was observed across countries, with portion weights in Spain and Italy considerably lower than the UK and France, and Belgium somewhere between these. The heaviest portions on average are served in France, but even at an average of 164g – out of home - this is still only 66% of the assumed 250g average weight.

The 2001 statement on Amnesic Shellfish Poisoning issued by the Committee on Toxicology highlighted the importance of obtaining additional data on the consumption of scallops to the determination of threshold levels. This report represents an important piece of the jigsaw in the discussion of threshold levels in providing intelligence on the purchase and consumption of scallops across five European countries. The findings and statistical approach will also have a valuable contribution to make to the planning and interpretation of future toxicological studies.

Chapter 1

Study Background and Objectives

Chapter 1 - Study Background and Objectives

1.1. Background

In 2003 the Sea Fish Industry Authority (Seafish) in partnership with industry commissioned a detailed research study to establish the weight of a scallop portion, in and out of home, in key European markets. The main purpose of this study was to establish some pertinent features of the distribution of the scallop portion weight in regions of heavy scallop consumption.

In 2003 landings of scallops into the UK were valued at almost £30 million. This study was prompted following the recommendation by the European Commission for a lower threshold for the presence of domoic acid, a neurotoxin that leads to Amnesic Shellfish Poisoning (ASP), a move which would inevitably lead to a greater number of area closures in coming years.

One of the factors currently underlying the calculation of threshold levels is the estimated average portion weight of scallops consumed by individuals across Europe. In the absence of such data until now, this has been assumed to be equal to that of mussels at 250g. The study was designed to fill this gap in the knowledge of portion weight in Europe for both in and out of home consumption of king scallops.

1.2. Aim and objectives

The aim of this study was to establish the key characteristics of the distribution of scallop portion weights, in and out of home, in key European markets. These characteristics include the mean, the variability or spread as measured by the standard deviation, the range as measured by the 1st and 99th percentiles, and other key percentiles including the 5th, 10th, 25th (the lower quartile), 50th (the median), 75th (the upper quartile), 90th, and 95th.

Detailed objectives were to identify:

- The pattern of consumer behaviour with respect to the purchase and consumption of scallops for in home consumption across the sample countries.
- The average portion characteristics (both number and weight) of scallops across the five European countries in question.
- Patterns of behaviour across restaurant outlets where scallops are served.
- The average portion characteristics (both number and weight) of scallops within each of the five European countries in question.

Chapter 2

Sample Design

Chapter 2 – Sample design

Introduction

Chapter two describes in detail the basis of and approach to sampling in this study. In each of the five countries studied up to 250 consumers were questioned about their consumption of scallops in home. The estimates for scallop consumption out of home were based on interviews with up to 100 restaurant owners/chefs in each of the countries.

2.1. Considerations for the choice of sample size

It was important that the study had adequate numbers of scallop purchasers and restaurants to produce accurate and precise estimates of the characteristics of interest. There follows a description of the reasoning behind and the calculations for the determination of the required sample sizes.

Reference datasets used in the sample size calculations

The sample approach was based on a number of datasets, listed below.

<table>
<tr><th>Source</th><th>Location</th><th colspan="2">Data Description</th></tr>
<tr><td rowspan="2">Gordon Goldsworthy</td><td rowspan="2">Scotland (central belt)</td><td>Adductor muscle plus gonads</td><td>N=74, Mean=132, Standard Deviation=52</td></tr>
<tr><td>Gonads</td><td>N=20, Mean=15.5, Standard Deviation=3.5</td></tr>
<tr><td>EU ASP Working Group Report[1]</td><td colspan="3">22 datasets from Spain, Republic of Ireland, Northern Ireland, Scotland, SAMS[2], FRS[3]. Data on about n=500 individual scallops, plus >200 pooled samples.</td></tr>
<tr><td>Food Standard Agency Report</td><td colspan="3">Exact sampling details are given in Annex 1 to the report (not available at time of writing)</td></tr>
</table>

[1]See Chapter 3 “Data Used in this Study” (Reference 6) for further details. 22 datasets in total were included
[2] the Scottish Association for Marine Science (West of Scotland)
[3] Fisheries Research Service (West of Scotland)

2.2. Sample size calculations – technical issues

2.2.1. Data source

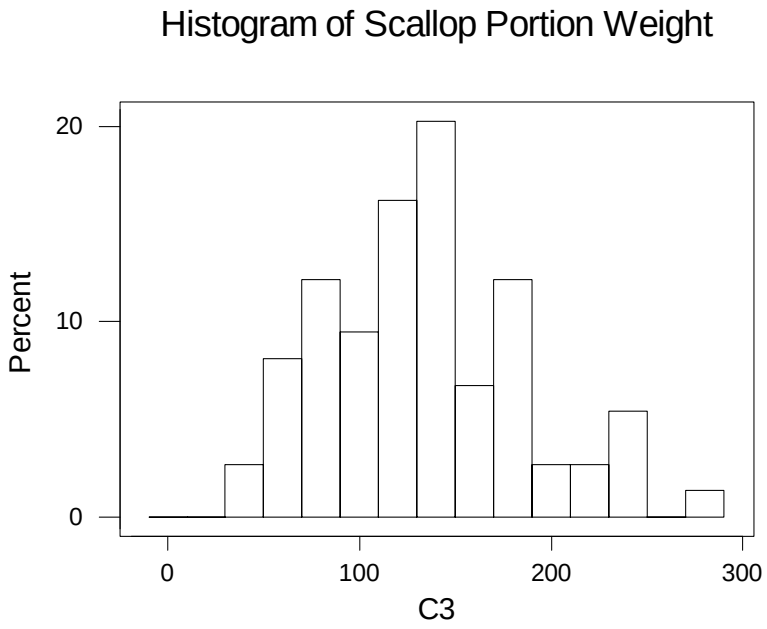
The principal data source used in this report on sample size calculations for portion size was the Gordon Goldsworthy data.

2.2.2. Distribution of scallop portion size

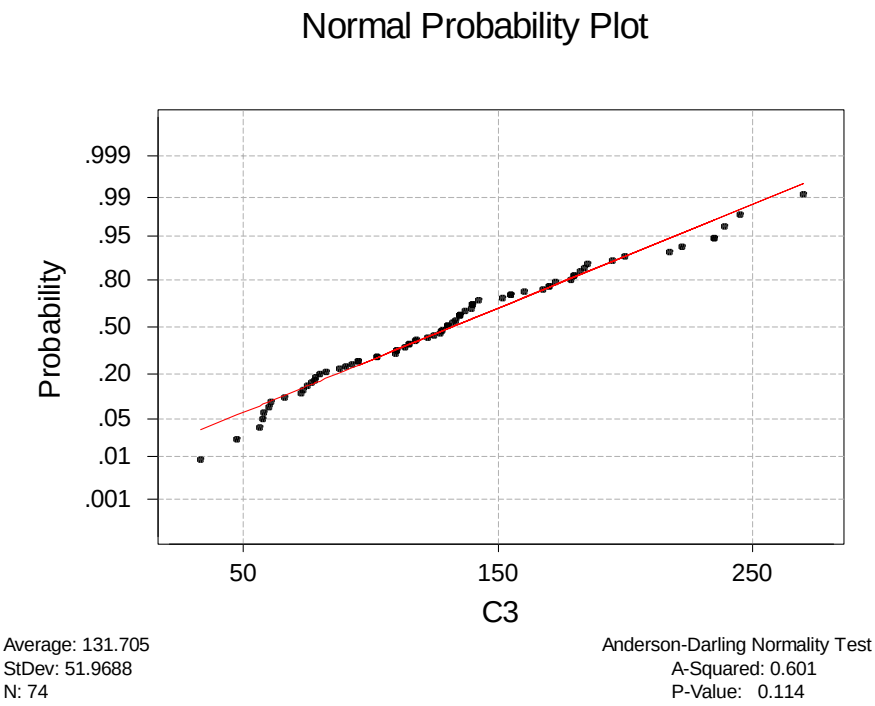
There was the technical issue of whether the distribution of portion size (assuming all the scallop is eaten) was approximately normally distributed, or whether some transformation was needed (e.g. a natural log transformation, as preferred by the authors of the EU Working Group report – reference 6). There was some evidence of lack of normality from the Goldsworthy data (a P-value of 0.022 using a Kolmogorov-Smirnov test of normality with 74 degrees of freedom), but by inspection of a box-plot of this data this was contributed to by one large value of 270g, 25g higher than the next largest value.

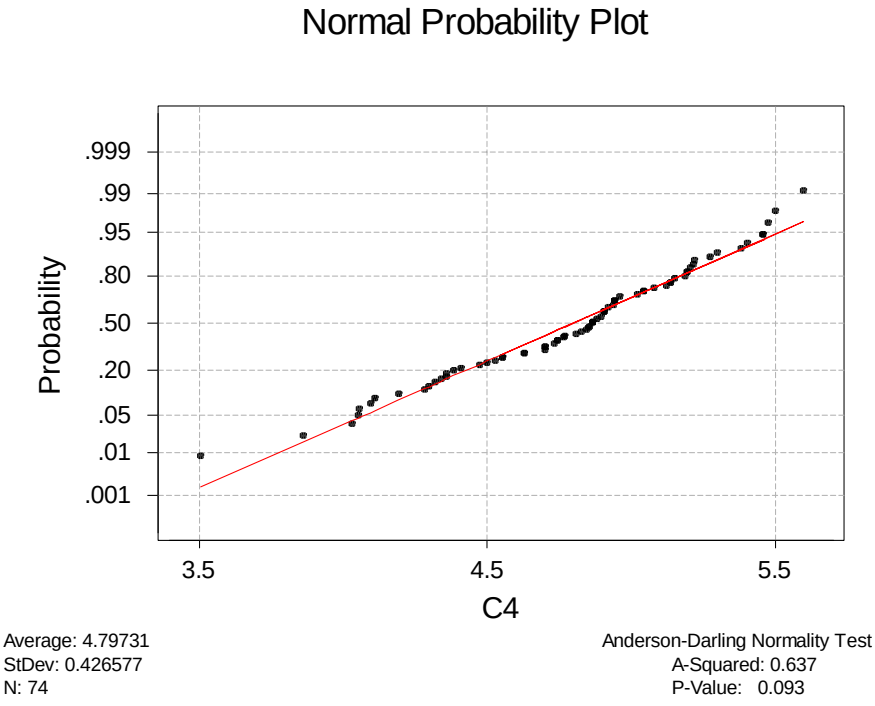
Overall

Clearly if the actual data was skewed to the right, and normality was assumed, the length of the tail of the distribution would be underestimated. This is potentially a problem when rehearsing sample size calculations specifically looking at, for example the 99th percentile of the distribution. Interestingly, however, the Anderson-Darling P-value for the n=74 Goldsworthy data was not significant, at P=0.11. The Anderson-Darling is generally felt to have better properties than the Kolmogorov-Smirnov test. The advantage of using the data without transformation is that the original scale of measurement was used, which was easier to interpret. So it was assumed that the untransformed data were approximately normally distributed. See the Normality plots below.



Normality plot for the n=74 Goldsworthy data – untransformed, and below that, for the log transformed data.



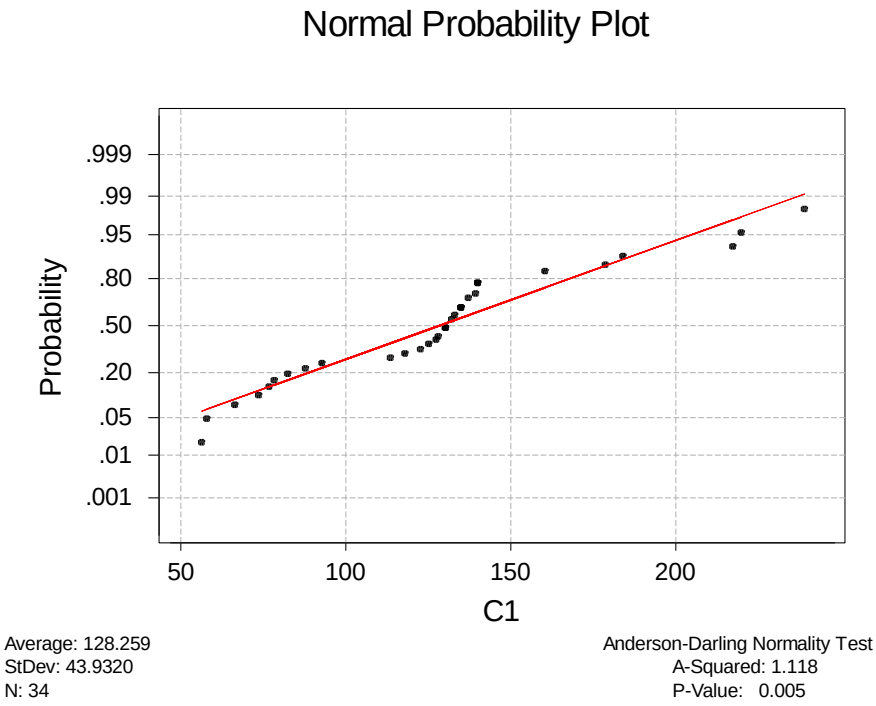


In and out of home

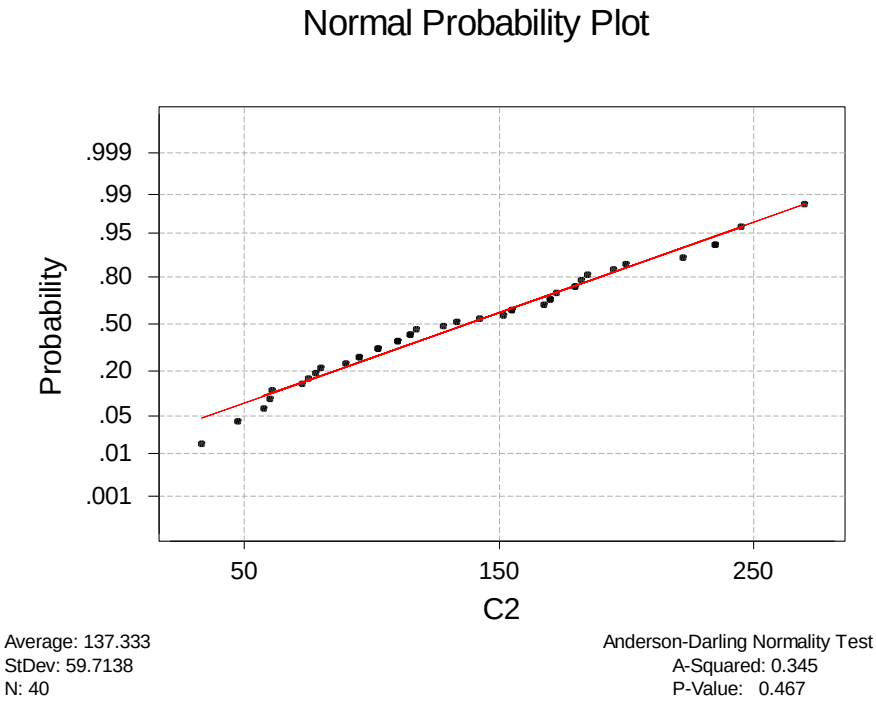
Note that for this sample of n=74, the data could be split further by in and out of home. For in home (n=40), the mean was 137g and the standard deviation 60g, while for the out of home (n=34), the mean was 128g and the standard deviation 44g.

The normality plots below show how well the data approximated to a normal distribution.

Out of home



In home



Although for the out of home data the Anderson-Darling test statistic was indicating a significant departure from Normality (P=0.005), by inspection of the plot this departure was generated principally by the bunching around the central location, and as such was not really a cause for concern when assuming approximate normality.

2.2.3. Properties of the Goldsworthy sample

The Goldsworthy sample was not a truly random sample, nor was it generated under replicable experimental conditions, and it was taken in one geographic location during one time period. Nevertheless, there was no reason to believe it would present a systematically distorted picture of scallop portion size, and is quite adequate and informative when used to inform the power calculations for the proposed study.

Sample size graphs

Use for in and out of home

The data from the Goldsworthy sample suggested that the in-home portions were on the average slightly larger (in terms of weight) than the restaurant portions (approximately 140g against 130g), but were slightly more variable (standard deviation 60g versus 44 g). Therefore, the sample size graphs that follow were used for estimating both the in and out of home sample sizes (the variability assumed ranges between 25g and 100g, encompassing both the 44g and the 60g standard deviations observed).

Clustering

However, there was an important difference between the in and out of home samples. For the in home consumer, a customer was approached at a retail outlet who had indicated that they wished to purchase scallops. The portion size was determined by the consumer. In the restaurant setting however, the customer was getting what the restaurant determined. It was important therefore to take a wide variety of restaurants, and not just (in extreme) 100 portions from the same restaurant. It was an assumption of these sample size calculations that each member of the sample contributed independently to the analysis – that might be the case in the supermarket, but would clearly not be the case within a restaurant (where all the portion sizes might be weighed out to be exactly 150g, for example).

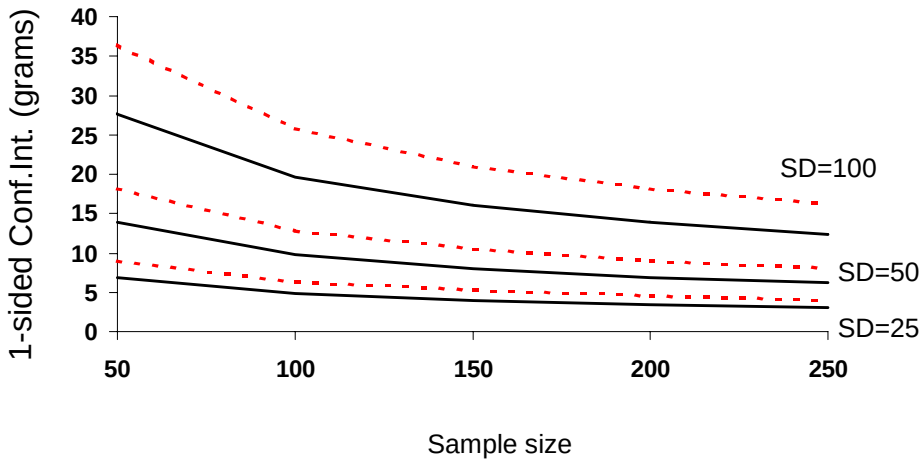
The samples within a restaurant are said to be clustered, and one view is that the effective sample size was the number of clusters (i.e. restaurants), not the number of portion sizes. In this view, having say ten portions from a restaurant would better enable one to estimate the mean portions size for that restaurant. So 100 portion sizes (ten each from ten restaurants) would give an effective sample size of ten, not 100. A more moderate view is that the effective sample size was between ten (the number of clusters), and 100 (the number of portions), the exact number depending on how similar the within cluster portions were in relation to how similar the portion sizes were between clusters.

Since this information was not known, the sensible way forward was to sample from as many restaurants as possible, up to n=100. It was also important to look at a variety of retail outlets as well as a variety of restaurants (e.g. fishmongers, small shops, supermarkets, open markets).

The figure below gives an insight into the precision with which the total scallop portion weight was estimated as a function of sample size. As indicated above, these graphs were used for estimating both the in-home and out of home samples, subject to the caveats in the discussions above.

Three scenarios were covered – an assumed standard deviation of 50 units (SD=50), roughly what was observed in the Goldsworthy data for the in and out of home consumption combined, and then assumed standard deviations of double that (SD=100), and half that (SD=25). For each of these three options, there was a power curve for a 95% (black solid line) and a 99% confidence limit (the red dotted line).

Figure 2: 1-sided 95% (black solid lines) and 99% (dashed lines) confidence intervals for the average total scallop portion size



For the highest variability (SD=100), with the lowest sample size (n=50), with the higher (99%) confidence band, the precision was least good –the average scallop portion weight to within +/- 35g approximately could be estimated. For the least variability (SD=25), for the highest sample size (n=250) and for the lower 95% confidence, the mean to within less than 5g could be estimated. In summary, on the basis of what was known from the Goldsworthy data, it was anticipated that with a sample size of about n=250 the average scallop portion weight to within about +/- 6g (with n=100 it would be +/- 10g) could be estimated.

The following table gives the data shown in Figure 2, the length of 1-sided confidence interval for average scallop portion weight, for different sample sizes, different assumed variations, and 95 and 99% confidence.

Table 3: 1-sided 95% (black solid lines) and 99% (dashed lines) confidence intervals for the average total scallop portion size

Sample size	σ=100 95% CI	σ=50 95% CI	σ=25 95% CI	σ=100= 99% CI	σ=50 99% CI	σ=25= 99% CI
50	27.7	13.9	6.9	36.4	18.2	9.1
100	19.6	9.8	4.9	25.8	12.9	6.4
150	16	8	4	21	10.6	5.3
200	13.9	6.9	3.5	18.2	9.1	4.6
250	12.4	6.2	3.1	16.3	8.1	4.1

Figure 3: 1-sided 95% (black solid lines) and 99% (dashed lines) confidence intervals for the average gonad portion size

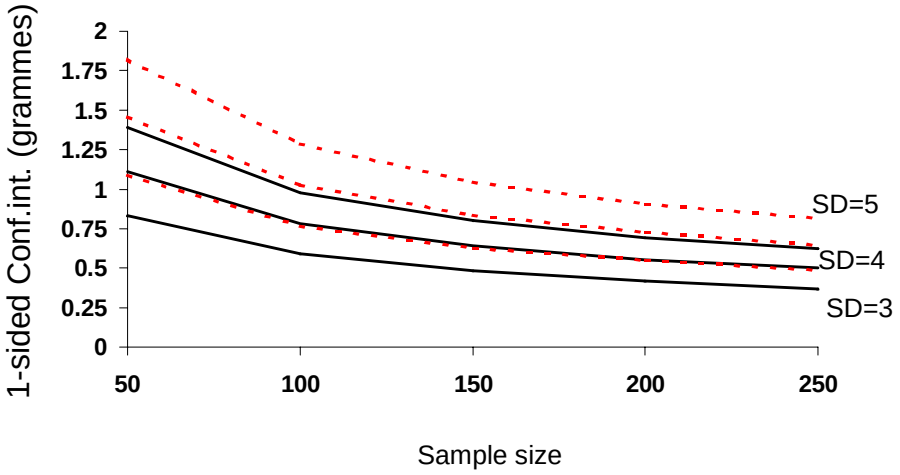


Figure 3 indicates that due to this reduced variability, the sample sizes returned more precise estimates – for around n=100 portions the gonad size to within about +/- 1g could be estimated.

99th percentile sampling

There was a lack of hard information about the average scallop size – either the whole scallop or the gonad part. In keeping with the philosophy of imagining the 'worst case scenario', there was some interest in looking at what sample size would be needed to estimate not the centre of the distribution (the mean), but something near an extreme value – such as the 99th percentile, or the value such that only 1 value in 100 would be greater than or equal to this value. Figure 4 gives the sample size calculation for the 99th percentile of a normally distributed random variate:

Figure 4: 1-sided 95% (black solid lines) and 99% (dashed lines) confidence intervals for the 99th percentile of total scallop portion size

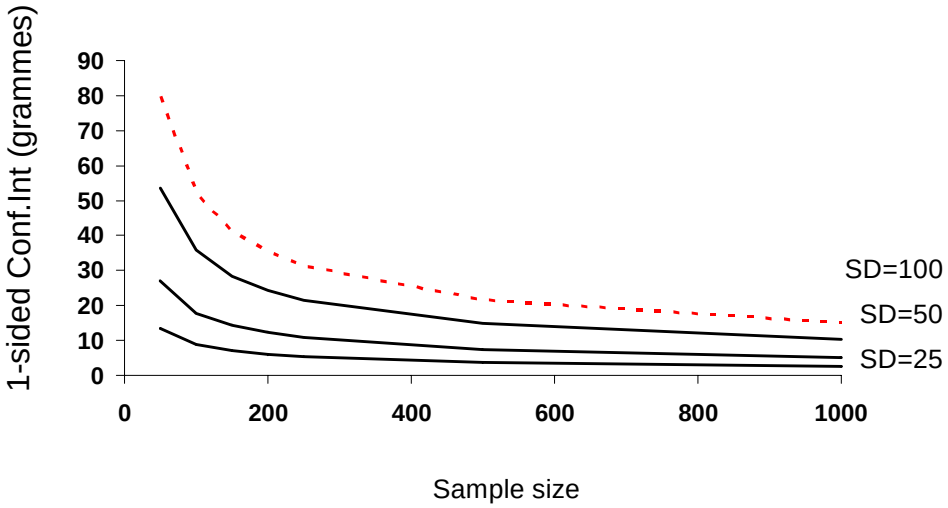


Table 4 outlines the data for Figure 4: length of 1-sided confidence interval for the 99th percentile* (in grams), according to sample size, assuming variability of σ (25, 50, 100) and 95% and 99% confidence.

Table 4: Length of 1-sided confidence interval for the 99th percentile* (in grams)

Sample size	σ=25, 95% CI	σ=50, 95% CI	σ=100, 95% CI	σ=100, 99% CI
50	13.4	26.8	53.6	79.8
100	8.9	17.9	35.8	52.3
150	7.1	14.3	28.5	41.4
200	6.1	12.2	24.3	35.2
250	5.4	10.8	21.6	31.1
500	3.7	7.5	14.9	21.4
1000	2.6	5.2	10.4	14.8

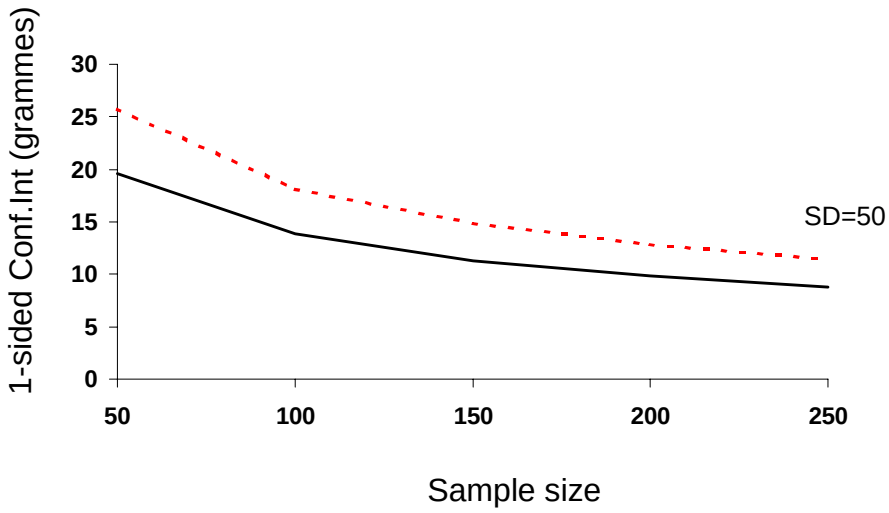
Comparison of two samples

The preceding sample size calculation considered one sample of portions. That is, this gave an indication of the number of portions needed to estimate the mean or the 99th percentile of a single sample, from a single location. As it was intended to compare several countries a two-sample test was required.

Figure 5 illustrates the required sample size to estimate a difference in means to a specified level of precision (1 side of the 95% confidence interval). For sake of clarity only the SD=50 case is presented. It is evident that a sample size of 100 in each location

would have been large enough to estimate a difference in the means of between +/- 15g. To get this down to about +/- 10g the sample size was increased to about N=250 in as many locations as possible.

Figure 5: 1-sided 95% (black solid lines) and 99% (dashed lines) confidence intervals for the difference in means of 2 samples (total portion weight)



It would not have been straightforward to perform a similar comparison of two 99th percentiles. However, one can see that just as the confidence interval for the 99th percentile was larger than for the mean, given the same sample size, so would the comparison of two more variable quantities. Therefore it would have been necessary to use a larger sample size if one wanted to compare the 99th percentiles rather than the means.

2.3. Collecting and weighing of scallop samples

It was recommended that during the data collection phase of this study, being conducted by Martin Hamblin Gfk, 20 samples of scallops (ten individual scallops in each sample) were collected from each country and returned to a UK laboratory for weighing and to estimate the gonad size, and the gonad to abductor muscle ratio. Previous work indicated that over 99% of the domoic acid was contained within the gonad part of the scallop, and as such it was this size rather than the total scallop size (and hence portion size) that was scientifically of most interest. It was not possible to measure gonad size accurately and non-destructively at the point of sampling so by taking samples with approximately 10 scallops (with gonads still on) in each sample, the study was able to estimate this gonad size.

- It was desirable that the analysis of sample weight and composition be conducted in an appropriate setting and by trained staff. Field staff were recruited primarily to conduct face to face interviews with respondents in the field and to record information.

While interviewers weighed the portions purchased by participants an allowance was not included to train staff in manipulating scallop samples to record separate weights. In a study which strove to be scientifically robust for obvious reasons, it would have been inappropriate to have interviewers dissecting and attempting to weigh accurately at point of sale.

- Transferring the separation of gonad and abductor muscle and the weighing of these to field workers would have inevitably lead to the introduction of error to the weights recorded. Many field workers were used across the five European countries and despite the issuing of protocols it would have been impossible to avoid differing approaches being taken. Returning scallop samples to the UK for analysis at one laboratory was suggested to avoid this and allow the weighing of all samples collected in a controlled laboratory environment.

2.4. Conclusion

In summary, a sample of n=250 consumers was chosen for the in-house element where it was possible to recruit this number, and n=100 restaurants for the out-of home element. Assuming for simplicity that the two shared a common standard deviation of 50 (we have seen in fact that the restaurants are a little less variable, the in home a little more variable), it was anticipated that this would allow the estimation of mean portions size to within about 6g, and the 99th percentile to within about 10g (20g with n=100). All these figures assumed calculating a 95% confidence interval around the estimate. For the comparison of two samples, n=250 allowed the detection of a difference between countries of about 10g (n=100 would permit detection of a difference of about 15g). All of these calculations assumed independence of observations. In the context of the restaurants, this required sampling n=100 restaurants, not, for example, many portions from the same restaurant.

2.5. References

1. Measurement of Domoic Acid in King Scallops processed in Scotland. Final Report for the Food Standards Agency. McKenzie JD, Bavington C. June 2002.

2. Gordon Goldsworthy (personal communication, Feb 2003). A study of n=74 portion sizes in the West of Scotland.

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Chapter 3

Data Collection

Chapter 3 - Data Collection

The data collection was conducted in two distinct stages; face to face interviews among scallop consumers and face to face interviews among restaurant owners/chefs.

In addition, during the interview stages at both the retail and the restaurant outlets, a random selection of 100 batches of ten scallops (all with the roe/gonad attached) were purchased from a variety of these retail outlets and restaurants and sent to Integrin Laboratories in Scotland for accurate weighing.

3.1. Face to face interviews among scallop purchasers

As discussed in chapter two, 250 interviews were conducted with scallop purchasers in each of the countries under study, each taking no longer than 15 to 20 minutes. These took place at point of sale (POS) in supermarkets, specialised shops and fish markets.

The structure for the consumer questionnaire was as follows:

- Screening - Scallop purchasers were observed at POS and if the consumer purchased scallops then an interview was requested.
- Number of scallops eaten in past year and number of household members if applicable
- Focus on scallops bought for consumption at POS
  - Weight of scallop bought
  - Type of scallops bought
  - Number of scallops eaten per sitting
  - Form scallops bought (live, fresh, frozen, prepared)
  - Parts of scallops to be used (Roe, gonad, black intestinal organs)
  - Planned method of preparation
  - Planned dish to be prepared
  - Number of people who ate the scallops
  - Age of people who ate the scallops
- Demographical data
  - Gender
  - Age
  - Socio demographics
  - Size of household
  - Region
  - Number of children
  - Etc.

3.2. Face to face interviews among catering personnel

Visits were also made to 100 restaurants in each country and focused on the preparation and size of scallops for dishes. Chefs/fish buyers working in fish restaurants, fish serving cafés and hotels were interviewed.
Outlets were pre-recruited for such interviews via telephone. Interviewers asked a screening question to ensure scallops were on the menu, and set up an appointment for the interview to take place.

The structure for the catering personnel was as follows:

- Screening question – do you prepare scallops to be served at the restaurant?
- Number of scallop dishes prepared
- For each dish prepared
  - Type of scallop bought and dish used for
  - Number of scallops eaten per portion
  - Form scallops bought (live, fresh, frozen, prepared)
  - Parts of scallops used (Roe, gonad, black intestinal organs)
  - Is the gonad or any other part of the scallop other than the adductor muscle used – if yes, how?
  - Methods of preparation
  - Dish prepared
  - How many portions sold per week/ sitting

3.3. Protocol for collection of samples for despatch to laboratory for analysis

- Ten scallops should be purchased and time of purchase and sampling point noted.
- Scallops should consist of muscle (white meat) and gonad (roe) combined (i.e. with gonad still attached to muscle.
- If the scallop is still whole ask the retailer to prepare (shuck) it so that only the muscle and gonad are left. Scallop samples collected should not be frozen however they can have been previously frozen.
- Place the scallops in a clean ziplock polythene bag (supplied). Put sample label (supplied) in bag with scallops and transfer them to coolbox, which should have either ice or frozen gel packs included. Labels must be placed inside the bag for safety. Field staff should be issued with pre-typed labels which are clearly legible as there can be problems reading handwriting.
- Transfer scallops within their ziplock polythene bag to polystyrene transport box (supplied). Place two frozen gel packs (supplied) in box and lay scallops on top of gel packs. Seal the box with tape and attach dispatch label (supplied).
- Give box to courier
- Inform study coordinator of sample being sent
- Next day delivery by courier is most desireable. Scallops will not be accepted if they received more than three days after collection.

Chapter 4

Study Findings

Chapter 4 – Study Findings

Introduction

This section presents in detail the findings of the scallop portion size study. A summary of findings can be found within the executive summary. Findings presented here relate to the average portion sizes of scallops consumed both in and out of home in the five countries under study.

The in home consumption of scallops is presented in part one and the average portion size of scallops consumed out of home is presented in part two. In addition to portion sizes the behaviour of consumers and restaurant outlets with respect to the purchase and consumption/serving of scallops is also discussed and the differences encountered across Europe.

There were two distinct 'units of study' – the scallop purchasers who were interviewed at the point of sale, and the scallop consumers, who were identified by the scallop consumer as the members of the household (or eg. guests at the dinner party) who were the intended consumers of the scallops that were being purchased on that day in that retail outlet. The results for these distinct 'units' are reported separately, with data on the n=1116 purchasers reported first and then data on the n=3498 scallop consumers that these n=1116 purchasers identified reported next.

Part 1. Consumption of scallops in home – the retail study

4.1. Description of sample

The study aimed to recruit 250 customers in the process of buying scallops in retail outlets in the five European countries under study. In practice, the study recruited 1116 customers (89% of the target number) who agreed to participate in the retail component of the study (with 253 in the United Kingdom, 251 in Spain, 249 in Italy, 250 in France, and 113 in Belgium).

Therefore in four of the five countries the target of n=250 was met. In the fifth country, Belgium, 45% of the target was met. This was despite extensive efforts on the part of the fieldwork staff (including extending the number of sites monitored, and the length of time over which the sites were monitored). This was mainly due to the poor availability of product at the time of the research.

Table 5 gives the purchasers' age and gender, household size, number of children, and occupational category of the main income earner, overall and by country.

Table 5: Retail purchasers by age and gender

Factor	Level	UK	SP	IT	FR	BE	Overall
Number of purchasers		253	251	249	250	113	**1116**
Gender	Male	123(49%)	75(30%)	47(19%)	74(30%)	31(27%)	**350(31%)**
Age (yrs)	Mean(SD)	49.5(12.4)	46.8(13.1)	46.6(11.1)	49.6(16.8)	45.5(15.9)	**47.9(13.9)**
	Min-Max	24-85	18-76	23-76	18-90	18-82	**18-90**
Household size	1	34(14%)	13(5%)	29(12%)	47(19%)	16(14%)	**139(13%)**
	2	119(47%)	97(39%)	80(32%)	127(51%)	55(49%)	**478(43%)**
	3	46(18%)	53(21%)	76(31%)	43(17%)	14(12%)	**232(21%)**
	4	37(15%)	60(24%)	55(22%)	23(9%)	18(16%)	**193(17%)**
	≥5	15(6%)	28(11%)	9(4%)	10(4%)	10(9%)	**72(6%)**
	Mean(SD)	2.56(1.20)	3.01(1.22)	2.75(1.07)	2.29(1.02)	2.57(1.18)	**2.64(1.16)**
Children	None	184(73%)	184(73%)	168(68%)	195(78%)	84(74%)	**815(73%)**
	1	27(11%)	45(18%)	56(22%)	38(15%)	13(12%)	**179(16%)**
	≥2	42(17%)	22(9%)	25(10%)	17(7%)	16(14%)	**122(11%)**
Occupation	A	15(6%)	73(29%)	26(10%)	59(24%)	*No data recorded in Belgium on occupation*	**173(17%)**
	B	103(41%)	46(18%)	42(17%)	83(33%)		**274(27%)**
	C1	89(35%)	104(41%)	85(34%)	15(6%)		**293(29%)**
	C2	29(11%)	22(9%)	29(12%)	5(2%)		**85(8%)**
	D	12(5%)	6(2%)	25(10%)	87(35%)		**131(13%)**
	E	4(2%)	0(0%)	42(17%)	0(0%)		**46(5%)**

From table 5, the following features emerge.

Gender: Overall purchasers were predominantly female (69%), with the UK exhibiting the highest proportion of males (49%), and Italy the lowest (19%) (differences between countries, P<0.0001, chi-squared test).

Age: The average age of scallop purchasers was broadly similar across countries, ranging from 45 years old in Belgium to almost 50 in France. With large numbers of subjects small differences attain statistical significance (P=0.006 , ANOVA F-test).

Household size: Purchasers were most commonly from two person households with the average household size overall being 2.64 (3.01 in Spain to 2.29 in France), and these differences were significant (P<0.0001, chi-squared test on proportions in each household size of 1, 2, 3, 4 and 5 or more).

Presence of children: The majority of households were childless (73%), ranging from 68% in Italy to 78% in France (P=0.0004, chi-squared test). Of the households that did have children, most (60%) had just one child.

4.2. Section 1 – Purchaser level analysis

4.2.1. Frequency of scallop purchase

Overall, approximately one third of purchasers bought scallops at least once a month, another third about once a quarter, and the remaining third less often, but at least once a year. This differed greatly by country. For example, less than 10% of respondents in Spain said they purchased scallops one or more times a month, however this rose to 48% of respondents in the UK and 53% of respondents in France.

Figure 6: Frequency of scallop purchase overall

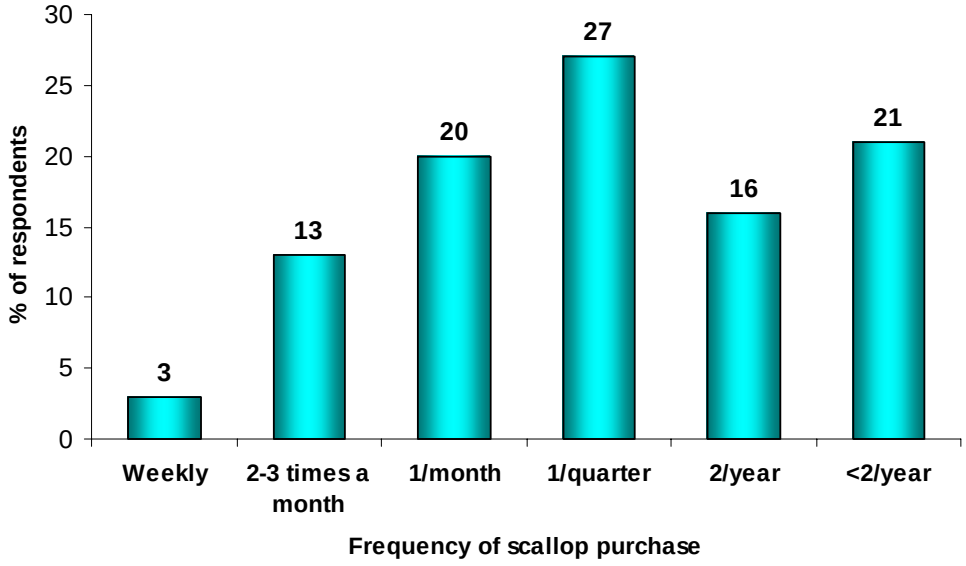


Table 6: Frequency of scallop purchase by country

Frequency	UK	SP	IT	FR	BE	Total
>1 /week	5(2%)	3(1%)	4(2%)	16(6%)	2(2%)	**30(3%)**
2-3 /month	46(18%)	7(3%)	35(14%)	55(22%)	7(6%)	**150(13%)**
1 /month	69(28%)	12(5%)	57(23%)	63(25%)	16(14%)	**217(20%)**
1 /2-3 months	66(26%)	51(20%)	92(37%)	59(24%)	33(29%)	**301(27%)**
1 /6 months	26(10%)	62(25%)	39(16%)	28(11%)	27(24%)	**182(16%)**
<1 /6months	38(15%)	116(46%)	22(9%)	29(12%)	28(25%)	**233(21%)**

Source: Q4

4.2.2. Quantity of scallops purchased

The figure below illustrates the number of scallops bought by the scallop purchaser on the interview occasion. Roughly one quarter of purchasers bought each of 1-4, 5-6, 7-10 and 11 or more scallops, with significant variation across countries (for example, 40% of those purchasing in France compared with 15% purchasing in Italy bought 11 or more scallops).

Figure 7: Quantity of scallops purchased overall

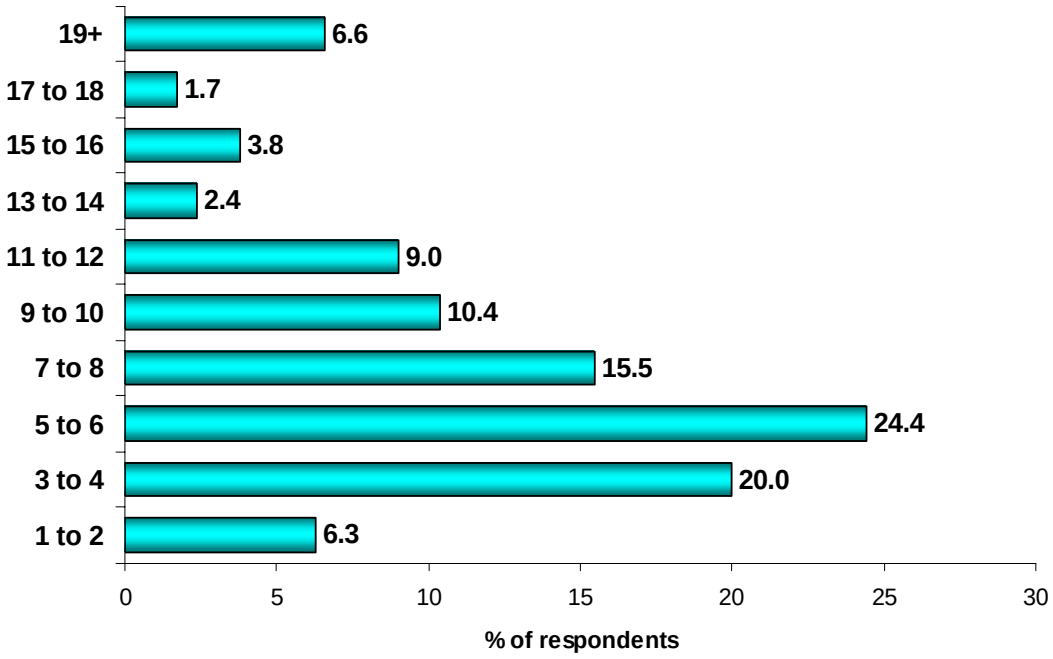


Table 7: Quantity of scallops purchased by country

Number bought on each occasion	UK	SP	IT	FR	BE	Total
1 to 2	9(4%)	19(8%)	28(11%)	10(4%)	4(4%)	**70(6%)**
3 to 4	38(15%)	56(22%)	69(28%)	39(16%)	20(18%)	**222(20%)**
5 to 6	82(33%)	77(31%)	43(17%)	43(17%)	26(23%)	**271(24%)**
7 to 8	53(21%)	25(10%)	45(18%)	39(16%)	11(10%)	**173(16%)**
9 to 10	26(10%)	27(11%)	26(10%)	22(9%)	15(13%)	**116(10%)**
11 to 12	28(11%)	25(10%)	14(6%)	24(10%)	9(8%)	**100(9%)**
13 to 14	4(2%)	6(2%)	3(1%)	6(2%)	8(7%)	**27(2%)**
15 to 16	4(2%)	5(2%)	10(4%)	18(7%)	5(4%)	**42(4%)**
17 to 18	0(0%)	1(0%)	3(1%)	14(6%)	1(1%)	**19(2%)**
19+	6(2%)	10(4%)	8(3%)	35(14%)	14(12%)	**73(7%)**

Source: Q5

4.2.3. Served as main course or starter?

Overall, two out of every three purchasers indicated that they intended serving the scallops as a starter course, ranging from a high of 95% in Spain to just 41% in the UK ($P<0.0001$, chi-squared test for difference between the five countries).

Table 8: Consumption of scallops by meal type

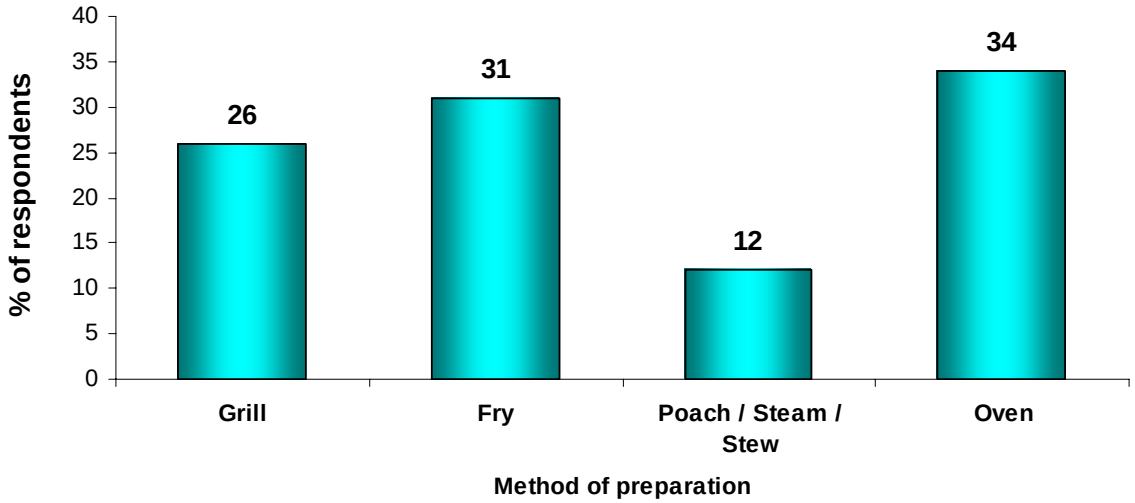
Country	Starter	Main Course
Overall	**745(67%)**	**370(33%)**
UK	104(41%)	148(59%)
SP	238(95%)	13(5%)
IT	179(72%)	70(28%)
FR	141(56%)	109(44%)
BE	83(73%)	30(26%)

4.2.4. Method of preparation in home

Method of cooking

Respondents planned on cooking their scallops in a number of ways, the two main methods being in the oven or frying.

Figure 8: Cooking methods used for preparing scallops



While frying was the method of preference in the UK and France, more Belgian and Spanish purchasers were planning to grill the scallops (chi-squared test P<0.0001 across the countries).

Table 9: Cooking methods used across countries

Country	Grill[1]	Fry[2]	Poach[3]	Oven[4]
Overall	**289(26%)**	**341(31%)**	**130(12%)**	**373(34%)**
UK	55(22%)	163(65%)	40(16%)	18(7%)
SP	120(48%)	18(7%)	40(16%)	97(39%)
IT	19(8%)	11(4%)	18(7%)	177(71%)
FR	19(8%)	115(46%)	29(12%)	81(32%)
BE	76(67%)	34(30%)	3(3%)	0(0%)

4.2.5. Form in which scallops have been purchased in the past

In addition to asking respondents what they planned on doing with the scallops they had just purchased they were also asked about the form in which they had purchased scallops in the past. Overall, fresh scallops tended to be purchased by respondents, with almost 80% of respondents saying they had purchased scallops in this format in the past. This was followed by those who had purchased scallops live (27%) and frozen (23%).

Across the countries, over 90% of purchasers in the UK, Belgium and Italy had bought scallops fresh, but this was the case for only just over half the Spanish purchasers. Over half the French purchasers had bought scallops live. All countries bought scallops frozen, ranging from 18% in the UK, Italy, France and Belgium, to over double that in Spain

where 38% had bought them frozen at some point in the past. In the UK, one in six purchasers had bought scallops 'prepared' in some fashion.

Figure 9: Form in which scallops were purchased in the past

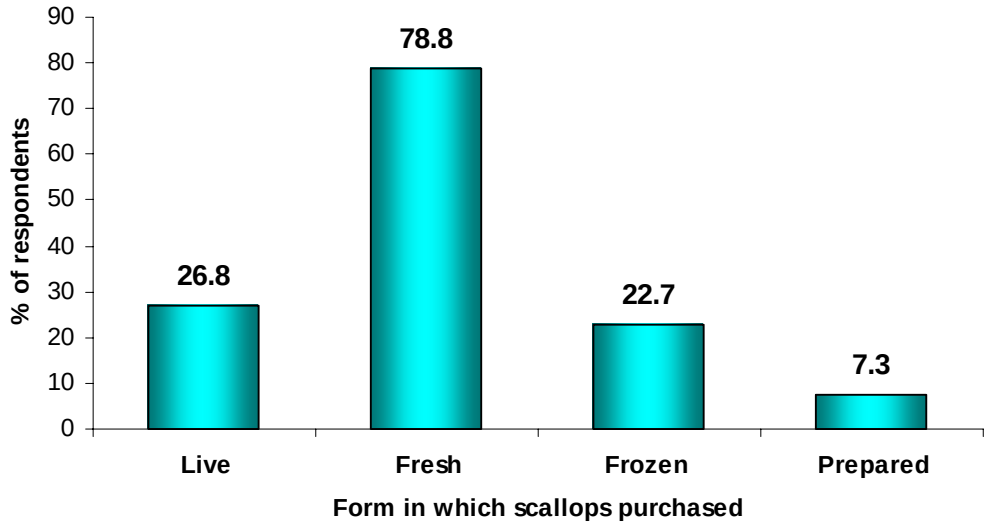


Table 10: Form in which scallops were purchased in the past by country

Country	Live	Fresh	Frozen	Prepared
Overall	**299(27%)**	**879(79%)**	**253(23%)**	**81(7%)**
UK	42(17%)	222(91%)	44(18%)	41(17%)
SP	73(29%)	137(55%)	95(38%)	1(0%)
IT	44(18%)	238(96%)	46(18%)	6(2%)
FR	130(52%)	180(72%)	46(18%)	24(10%)
BE	10(9%)	102(90%)	22(19%)	9(8%)

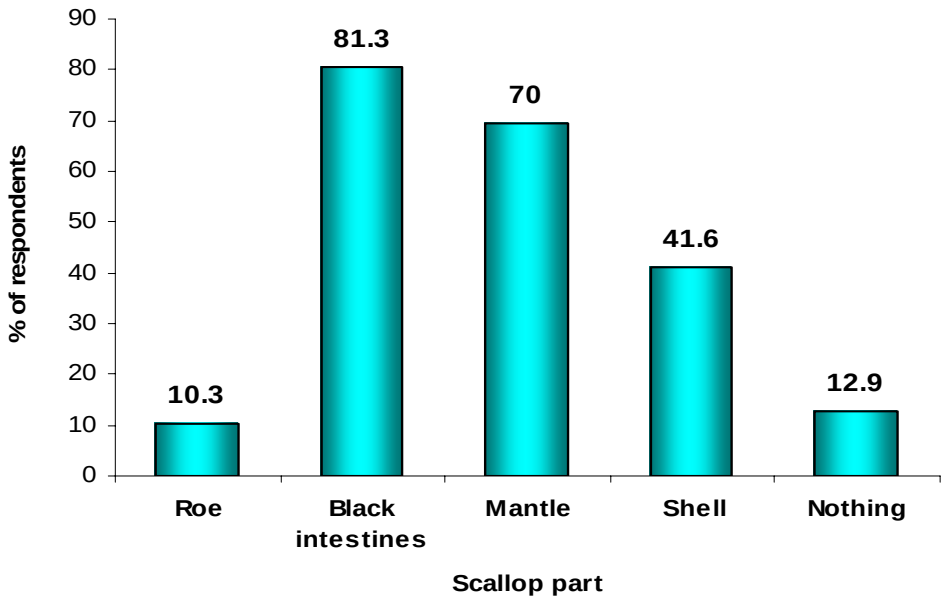
Source: Q7a

Note that percentages do not necessarily add to 100 since multiple responses were allowed
6 had never purchased scallops before; 4 gave no answer; 8 were 'other' (excluded above).

4.2.6. Use of individual scallop pieces

Considering the scallop as a whole and the parts used, respondents were asked which parts they generally threw away during preparation of the dish. The black intestines (81%) and mantle (69%) were most often thrown away before serving, followed by the shell (41%).

Figure 10: Parts of scallop thrown away by respondents before serving



Across all countries, on average 10% of purchasers discarded the roe/gonad. The highest proportion of these was in Spain (16%), the lowest the UK (7%), P=0.0082 (Fisher Exact test for differences across countries).

Table 11: Parts of scallop thrown away by respondents before serving

Country	Roe / Gonad	Black Intestinal Organ	Mantle (Frill)	Shell
Overall	**101(10%)**	**797(81%)**	**686(70%)**	**408(42%)**
UK	17(7%)	164(71%)	148(64%)	136(59%)
SP	40(16%)	218(88%)	196(79%)	51(20%)
IT	20(8%)	178(71%)	134(54%)	38(15%)
FR	24(10%)	237(95%)	208(83%)	183(73%)

Source: Q8a

Note that percentages do not necessarily add to 100 since multiple responses were allowed.

The following table shows that in almost all cases the roe was retained, and was served, possibly to be eaten. Very few respondents across countries used it either in stock or as decoration.

Table 12: Use of roe/gonad

Country	Serve, possibly to be eaten	Served as decoration	Used as stock	Other
Overall	**820(96%)**	**21(2%)**	**19(2%)**	**1(0%)**
UK	183(96%)	5(2%)	2(1%)	1(1%)
SP	197(94%)	6(3%)	6(3%)	0(0%)
IT	228(100%)	0(0%)	2(1%)	0(0%)
FR	212(95%)	10(5%)	9(4%)	0(0%)

Source: Q8b
Note: no data recorded for Belgium; 1 response as 'Don't Know'
Note that these conditional percentages using the total that keep the roe/gonad. To get the percentage for the whole sample, multiply through by the proportion keeping the roe/gonad.

4.3. Section 2 – Consumer level analysis

The consumer level analysis reports on the findings for the n=3498 consumers identified as being the intended eaters of the scallops purchased in the retail outlets by the n=1116 purchasers interviewed. On average within the 1106 households under study, respondents planned on serving the scallops being purchased to an average of 3.16 consumers, ranging from 2.41 in the UK to 4.0 in Spain and Belgium. Consumers were evenly split between male and female, with the average age being just under 44 years old (from 46 in France to 42 in Spain).

Table 13: Demographics of consumers

Factor	Level	UK	SP	IT	FR	BE	Total
Number of consumers		607	990	745	720	437	3498
Number of households	N	252	247	249	249	109	1106
Number of scallop consumers per household	Mean	2.41	4.01	2.99	2.89	3.99	3.16
	SD	1.58	2.27	1.45	1.58	2.37	1.94
	Median	2	4	3	2	4	2
Gender of consumer	N(%) male	312 (51%)	471 (48%)	376 (50%)	353 (49%)	280 (64%)	1792 (51%)
Age of consumer	Mean	45.5	41.9	42.5	46	43.7	43.7
	SD	14.8	16.8	14.5	18.3	17.2	16.4
	Range	1-90	3-88	2-87	2-90	4-82	1-90

4.3.1 Number of scallops consumed

Overall an average of 2.72 scallops were consumed by consumers in home, ranging from 2.05 in Spain to 3.58 scallops in France (ANOVA P<0.0001 for country differences).

Table 14: Number of scallops consumed by consumers across countries under study

	UK	SP	IT	FR	BE	Total
Number of scallops consumed						
1	86(14%)	415(42%)	151(21%)	41(6%)	80(18%)	773(22%)
2	152(25%)	361(36%)	333(45%)	142(20%)	143(33%)	1131(32%)
3	168(28%)	126(13%)	129(17%)	209(29%)	108(25%)	740(21%)
4	131(22%)	52(5%)	61(8%)	163(23%)	59(14%)	466(13%)
5	22(4%)	10(1%)	24(3%)	78(11%)	29(7%)	163(5%)
6	36(6%)	0(0%)	22(3%)	52(7%)	9(2%)	119(3%)
7+	12(2%)	26(3%)	25(3%)	35(5%)	7(2%)	105(3%)
Statistics						
Number of scallop consumers	607	990	745	720	435	3497
Mean number of scallops consumed	3.02	2.05	2.55	3.58	2.73	2.72
SD (number of scallops consumed)	1.46	1.57	1.55	1.59	1.48	1.64
Median number of scallops consumed	3	2	2	3	2	2

4.3.2. A statistical model for the number of scallops in a portion

A statistical model (a normal linear model) was fitted to investigate the factors that might influence the number of scallops in a portion. The factors on which data were available comprised country, consumer gender and age and household size. The following table gives the number of subjects, and the raw mean (standard deviation) of the number of scallops in a portion for each level of the factor, and the P-value from a multivariate model containing all the covariates jointly.

Table 15: Influence on country, consumer age and sex, and household size on the number of scallops in a portion

Factor	Level	Number of consumers	Mean (SD)	P-value
Country	**UK**	603	3.02(1.46)	<0.0001
	SP	971	2.05(1.56)	
	IT	745	2.55(1.55)	
	FR	716	3.58(1.59)	
	BE	407	2.80(1.49)	
Gender	**Male**	1786	2.83(1.67)	0.0005
	Female	1656	1.64(1.58)	
Age*	**0-5**	23	2.17(1.80)	0.0039
	6-20	272	2.51(1.63)	
	21-30	479	2.55(1.60)	
	31-40	768	2.84(1.69)	
	41-50	774	2.71(1.56)	
	51-60	601	2.70(1.49)	
	61-70	359	2.92(1.65)	
	71+	166	3.11(2.08)	
Shell	**Whole**	1316	2.90(1.65)	<0.0001
	Non-Whole	2126	2.64(1.62)	
Household size	**1**	314	3.29 (2.08)	<0.0001
	>1	3128	2.68 (1.57)	

*Age fitted as a continuous covariate (in the same multivariate model) has an estimate (standard error) of 0.037(0.016) P=0.0098 for every 10 years additional age.

The next table selectively reports the most extreme contrasts among levels of the factors in the model, to give a feel for the estimated differences among these levels.

For example, the difference between France and Spain, having adjusted for the effects of age and sex and household size, is estimated at 1.44 scallops per portion (France having on average 1.44 scallops more in a portion than their Spanish neighbour), with a 95% confidence interval of between 1.29 and 1.59 scallops. That is, the best estimate of the difference is 1.44 scallops, with 95% confidence that the true difference will lie somewhere between 1.29 and 1.59 scallops. The P-value for this contrast is P<0.0001 –

that is, there is less than 1 chance in 10,000 that a difference of this magnitude (or greater) would have been seen if in fact there was no difference between the two countries. In a similar vein, the difference between the youngest and the oldest consumers is just under one scallop (0.84, with a 95% confidence interval of 0.17 to 1.50, P=0.14). Males had portion sizes about 0.18 scallops larger, and being in a single household increased the number of scallops in a portion by about 0.39 scallops.

Table 16: Selected contrasts between levels of factors: estimates of mean differences across country, age and gender in the number of scallops in a portion

Factor	Level	Mean diff	95% Confidence interval	P-value
Country	FR Vs. SP	1.44	1.29 to 1.59	<0.0001
Age	>71 Vs. <5	0.84	0.17 to 1.50	0.014
Gender	Male Vs. female	0.18	0.07 to 0.28	0.0005
Household size	1 Vs. >1	0.39	0.21 to 0.57	<0.0001
Shell	Whole vs. Not whole	0.37	0.25 to 0.50	<0.0001

A sometimes useful way of presenting the results is via a 'ready reckoner' for the number of scallops in the portion. The table below contains an example.

Table 17: Scallop portion size ready reckoner (number of scallops consumed)

	Resulting mean portion size				
Factor	**UK**	**SP**	**IT**	**FR**	**BE**
START	**2.70**	**1.56**	**2.15**	**3.00**	**2.47**
Age	+0.05 per 10 years				
Gender	+0.15 for male				
Household size	+0.33 for single				
Shell On	0.37 for whole				

So for example, a 50 year old male living alone in the UK who purchased his scallops shell on would have an estimated number of scallops of 2.70 + (5*0.05) + 0.15 + 0.33 + 0.37 = 3.80 scallops. A ten year old Italian girl whose parent bought the scallops without the shell on would have an estimated number of scallops of 2.15 + (1 *0.05) + 0 + 0 + 0 = 2.20 scallops. As with all statistical models, caution should be exercised when extrapolating beyond the data: while it is possible to calculate any combination of these factors, bear in mind there may be few (indeed, if any) such people in the dataset used to derive the model.

4.3.3. Statistical models for the weight of a scallop portion.

Ideally, the analysis reported in the previous section (for the number of scallops in a portion) would have been repeated for the next outcome of interest – the weight of scallops in a portion. However, there was a fundamental difficulty in doing this. Whereas it is possible to accurately record the number of scallops that have been bought and to ask how many consumers they are intended for, it is very difficult to accurately record the weight of just the adductor muscle and the roe/gonad of the scallops being purchased. This is because scallops are sold at the retail outlets taking part in this study in a variety of formats – with the whole shell on, with a half shell with all the scallop parts intact, with a half shell with only the adductor muscle and roe/gonad attached, and finally as just adductor muscle and gonad/roe. It was not feasible to measure just the adductor muscle and gonad/roe for those supplied in whole or half shells without spoiling the customers purchase.

Therefore, to estimate the weight of adductor muscle plus roe/gonad for the n=3498 consumers – for whom country, age, sex, and intended number of scallops consumed was recorded – a simulation study was conducted using the empirical distribution of the accurately laboratory weighed scallops (the total of adductor muscle plus roe/gonad) purchased at retail outlets in each country.

Given the number of scallops for each consumer, we sample with replacement this number of scallops weights from the relevant country/retail distribution of scallop weights. The exception was Spain, which only supplied data for laboratory weighing from restaurants. The restaurant data (rather than retail data from other countries) was used as a proxy, since it was felt that country differences were of a larger magnitude than restaurant-retail differences within countries. The weight for each consumer was then calculated by summing the weights of the scallop weights selected. This was done for each consumer within that country, and then the summary statistics for that realisation of scallop weight for that country were calculated. These summary statistics were stored, and then the process repeated 1000 times. The descriptive statistics of these 1000 sets of summary statistics were then calculated, so yielding estimates of the distributional characteristics of the scallop weights, but also empirical estimates of the variability of these characteristics.

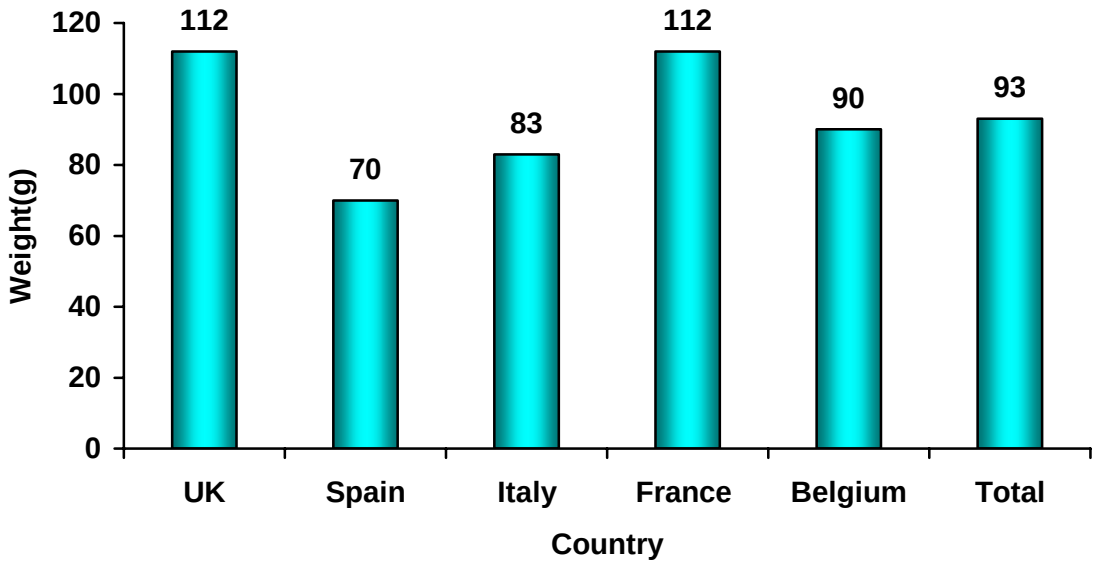
These simulations were conducted for each country, for starters and main courses separately, for starters plus main courses combined. The estimates reported for all countries aggregated were calculated by pooling the simulations for each country, and then calculating the summary statistics and percentiles for the combined distribution.

The following table shows the results of the simulation study for the starters plus main dishes combined. The data shown are the number of consumers, then the mean, standard deviation, median, and 1st and 99th percentiles of the total weight (adductor muscle plus roe/gonad) of the scallop portions in grams.

Table 18: Results of the simulation study for the starters plus main dishes combined

Retail	N	Mean	SD	Median	1st percentile	99th percentile
UK	607	112	59	105	21	287
Spain	990	70	57	56	15	354
Italy	745	83	53	68	19	278
France	720	112	55	103	20	271
Belgium	437	90	50	79	21	273
Overall Retail	**3498**	**93**	**55**	**83**	**19**	**292**

Figure 11: Mean portion weight by country

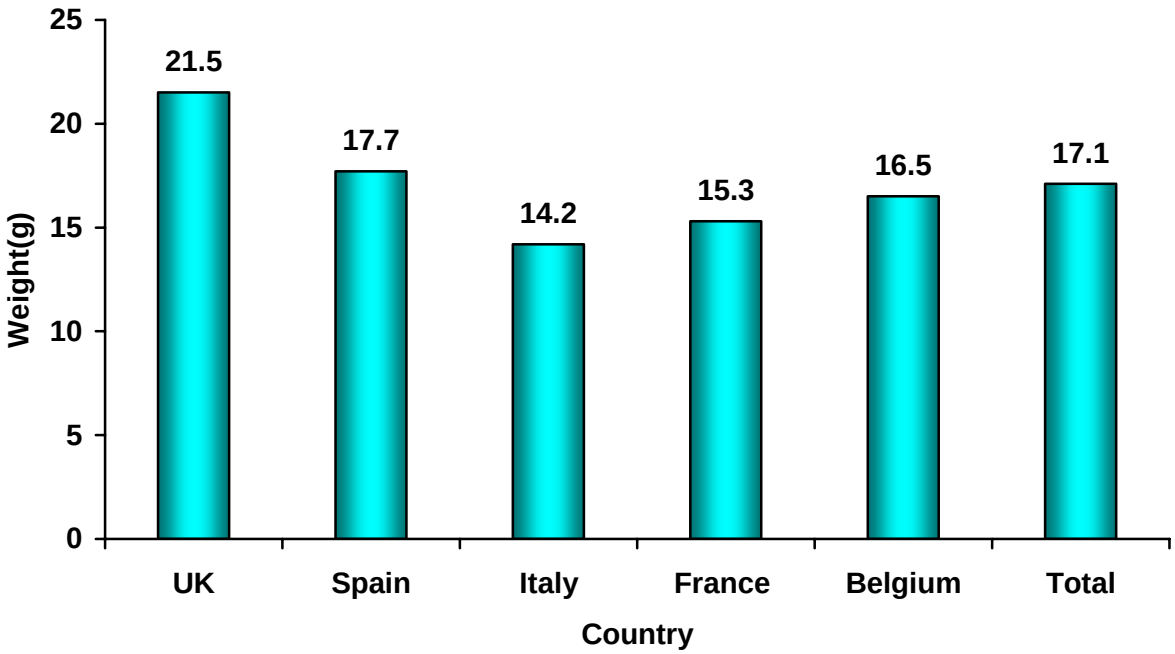


The pair wise differences between the countries were all significant at P<0.0001 using two sample t-tests assuming equal variance for both countries, except the comparisons between UK and France (112g vs. 112g, P=0.99) and Italy and Belgium (83g vs. 90g, P=0.023)

Table 18a: Results of the simulation study for the weight of gonad consumed (assuming all consumers eat the gonad) for the starters plus main dishes combined

Retail	Number of consumers	Mean Gonad portion weight	SD of gonad portion weight	Median gonad portion weight	1st percentile	99th percentile
Overall Retail	**3498**	**17.1**	**12.2**	**14.3**	**1.6**	**61.1**
UK	607	21.5	14.5	18.3	1.5	66.6
Spain	990	17.7	16.1	13.5	0.7	90.3
Italy	745	14.2	10.6	11.3	1.5	52.1
France	720	15.3	10.1	13.4	1.1	95.9
Belgium	437	16.5	9.8	14.8	3.0	50.8

Figure 11a: Mean gonad portion weight by country



The pair wise differences between the countries were all significant at P<0.0001 using two sample t-tests assuming equal variance for both countries, except the comparisons between Spain and Belgium (17.7 vs. 16.5, P=0.084), Italy and France (14.2 vs. 15.3, P=0.042) and France and Belgium (15.3 vs. 16.5, P=0.046).

Scallop Portion Size Ready Reckoner

The ready reckoner is calculated by taking the estimated number of scallops from the statistical model (as reported in Table 17) and applying them to the mean whole scallop (adductor muscle plus gonad) weights given in Table 36.

Table 19: Scallop portion size ready reckoner (weight of scallop portion, assuming roe/gonad attached)

Factor	Resulting mean portion weight				
	UK	SP	IT	FR	BE
START	96	54	62	99	93
For every ten years of age, add	2	2	2	2	2
For male gender, add	5	5	4	5	6
For single household, add	12	11	9	11	12
For shell on, add	13	13	11	12	14

So for example, a 50 year old male living alone in the UK who purchased scallops shell on would have an estimated scallop portion weight of 96 + (5*2) + 5 + 12 + 13 = 136g. A ten year old Italian girl whose parent bought the scallops without the shell on would have an estimated number of scallops of 62 + (1*2) + 0 + 0 + 0 = 64g of scallops. As with all statistical models, caution should be exercised when extrapolating beyond the data: while it is possible to calculate any combination of these factors, bear in mind there may be few (indeed, if any) such people in the dataset used to derive the model.

Table 19a: Scallop gonad portion size ready reckoner (weight of scallop gonad portion)

As mentioned above the ready reckoner is calculated by taking the estimated number of scallops from the statistical model (as reported in Table 17) and applying them to the mean gonad weights given in Table 35.

Factor	Resulting mean gonad portion weight				
	UK	SP	IT	FR	BE
START	14.7	13.5	11.1	13.9	19.1
For every ten years of age, add	0.3	0.4	0.3	0.2	0.4
For male gender, add	0.8	1.3	0.8	0.7	1.2
For single household, add	1.8	2.8	1.7	1.5	2.6
For shell on, add	2.0	3.2	1.9	1.7	2.9

So for example, a 50 year old male living alone in the UK who purchased scallops shell on would have an estimated scallop gonad portion weight of 14.7 + (5*0.3) + 0.8 + 1.8 + 2.0 = 20.8g of scallop gonad. A ten year old Italian girl whose parent bought the scallops without the shell on would have an estimated number of scallops of 11.1 + (1 *0.3) + 0 + 0 + 0 = 11.4 g of scallop gonad. As with all statistical models, caution should be exercised when extrapolating beyond the data: while it is possible to calculate any combination of these factors, bear in mind there may be few (indeed, if any) such people in the dataset used to derive the model.

Part 2: Consumption of scallops out of home – restaurant study

4.4. Description of sample

The restaurant study delivered data on 504 restaurants across the countries under study (100 in each of Spain, Italy, France and Belgium, and 104 in the UK). Both urban and rural restaurants were recruited including a mix of specialist seafood restaurants and more general purpose restaurants with scallop dishes on the menu.

4.5. Method of reporting

Similar to the case with the in home study where analysis was undertaken at two levels, the purchaser and consumer, the analysis of restaurant data was also conducted on two levels, the restaurateur and the consumer. Whereas for the in-home study, the 'consumer' was the reported number of people in the household or visiting the household (e.g. dinner guests) that would consume the scallops that had just been purchased at the retail outlet, in the restaurant study this was the reported number of people who, according to the restaurateur, would eat each dish that was available in a typical week. Note that unlike the in-home consumers, demographic data (age and sex) was not available on these consumers.

Restaurateurs gave information on the quantity of scallops bought per week, the number of covers within the restaurant and methods of preparation and serving. Data given by restaurateurs is described as restaurant level data and is based on the sample size of n = 504 restaurateurs. The data provided by restaurateurs on the number of dishes served and number of people consuming scallops enabled reporting at consumer level based on a total of n = 24,340 consumers across these 504 outlets.

Note that when reporting the consumer level analyses, the term 'per person' is used. It is assumed that each person only consumes 1 scallop dish at each sitting.

4.6. Section 1 - Restaurant level analysis

4.6.1. Weight of scallops purchased per week

Overall just under 10kgs of scallops were being bought on average by restaurants each week, ranging from over 14kgs in France to under 6kgs in Britain. Restaurateurs tended to purchase quite similar quantities each season, while there was some evidence of more scallop purchase during the summer in Italy and the UK, and during the winter in France (data not shown).

Table 20: Weight of scallops bought per week (kgs)

Factor	Level	Number of restaurants	Mean	SD	50%
Overall		392	9.82	8.11	5.5
Country	**UK**	101	5.85	4.64	3.5
	SP	99	8.31	5.74	7.5
	IT	*No data recorded*			
	FR	95	14.19	9.42	11.5
	BE	97	11.23	9.24	7.5

Source: Q1a
The data collection form recorded this information in aggregated form in bands of 2 kg i.e. 1-2, then 3-4, and so on up to 19-20, with an open ended upper bin of 21kg. We took the midpoints of these bins i.e. 1.5, 2.5,...,19.5 and then fixed a notional upper weight of 25kg for the upper bin.

4.6.2. Point of purchase

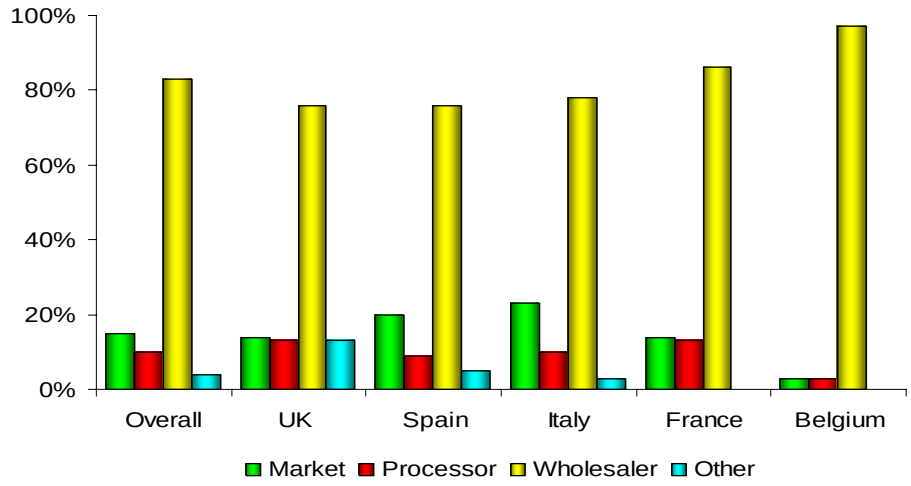
Scallops were principally purchased from wholesalers (83%). This was particularly the case in Belgium where 97% of scallops had been sourced from wholesalers.

Table 21: Channel of distribution for scallops purchased

Level	Market	Processor	Wholesaler	Other
Overall	75(15%)	48(10%)	416(83%)	21(4%)
UK	15(14%)	13(13%)	79(76%)	13(13%)
SP	20(20%)	9(9%)	76(76%)	5(5%)
IT	23(23%)	10(10%)	78(78%)	3(3%)
FR	14(14%)	13(13%)	86(86%)	0(0%)
BE	3(3%)	3(3%)	97(97%)	0(0%)

Source: Q1f
Note that multiple responses were allowed, so percentages do not sum to 100.

Figure 12: Channel of distribution for scallops purchased



4.6.3. Format in which scallops are purchased

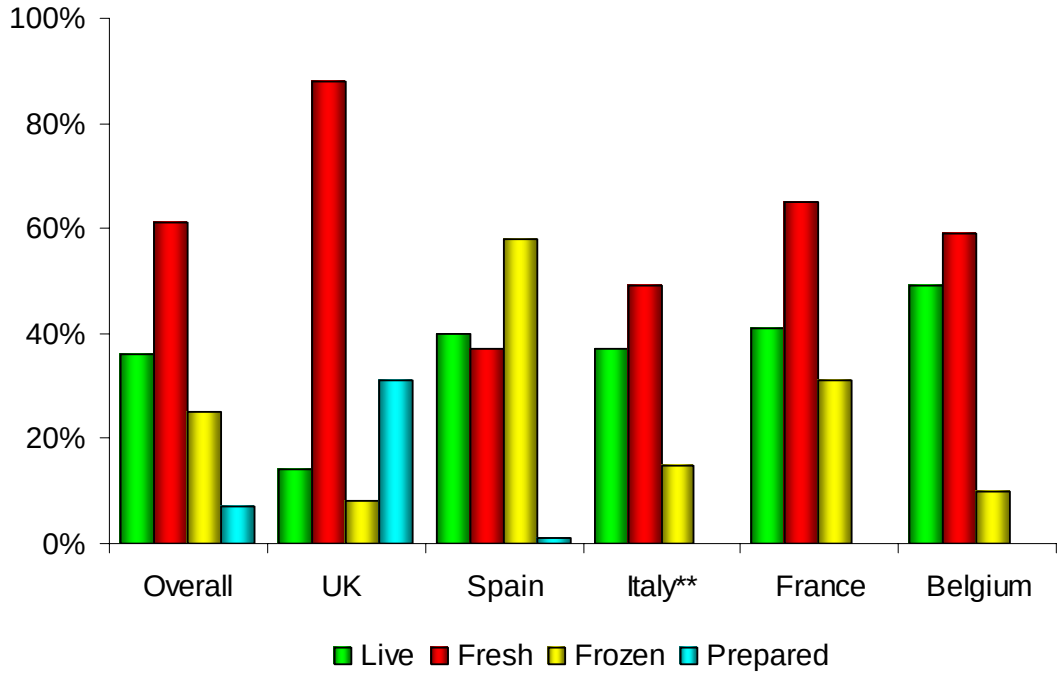
There was some variation in the format in which scallops were purchased across countries. Overall 61% of scallops were purchased fresh. This rose to 88% in the UK however fell to just 37% in Spain, where buying frozen animals was preferred.

Table 22: Format in which scallops are purchased

Group	Live	Fresh	Frozen	Prepared
Overall	**160(36%)**	**272(61%)**	**113(25%)**	**33(7%)**
UK	15(14%)	91(88%)	8(8%)	32(31%)
SP	40(40%)	37(37%)	58(58%)	1(1%)
IT**	15(37%)	20(49%)	6(15%)	0(0%)
FR	41(41%)	65(65%)	31(31%)	0(0%)
BE	49(49%)	59(59%)	10(10%)	0(0%)

Source: Q4a
** Other: dried, other unspecified*
*** 59 restaurants (of 100) in Italy did not supply this data*

Figure 13: Format in which scallops are purchased



4.6.4. *Country of origin of scallops*

Where known, restaurateurs also indicated where the scallops they purchased were from. Overall more scallops were purchased from the UK and Ireland than any other region, however this differed significantly from country to country, with almost ninety percent of the scallops purchased from restaurateurs in France coming from France.

Table 23: Country of origin of scallops

Group	UK/Ireland	France	Spain	Other
Overall	**264(56%)**	**159(34%)**	**69(15%)**	**60(13%)**
UK	92(100%)	0(0%)	0(0%)	0(0%)
SP	34(36%)	6(6%)	69(73%)	5(5%)
IT	90(100%)	0(0%)	0(0%)	0(0%)
FR	23(23%)	89(89%)	0(0%)	19(19%)
BE	25(26%)	64(67%)	0(%)	36(38%)

Source: Q1e
Note that these percentages are not constrained to sum to 100 – more than 1 country may be specified. Note that n=33 restaurants missing data on this item.

4.6.5. Scallop preparation

Parts of scallop thrown away

While the majority of restaurateurs across countries threw the black intestines and mantle away when preparing scallops, none of those interviewed said they threw the roe/gonad away.

Table 24: Parts of scallop thrown away

Country	Roe/Gonad	Black Intestines	Mantle	Shell	Blackline Gill
Overall	**0(0%)**	**442(94%)**	**379(81%)**	**212(45%)**	**21(4%)**
UK	0(0%)	66(87%)	57(75%)	32(42%)	18(24%)
SP	0(0%)	95(98%)	84(87%)	23(24%)	1(1%)
IT	0(0%)	91(93%)	62(63%)	7(7%)	0(0%)
FR	0(0%)	95(95%)	83(83%)	66(66%)	2(2%)
BE	0(0%)	95(96%)	93(94%)	84(85%)	0(0%)

Source: Q5
Note that there were n=12 restaurants with no data for this question. In addition, there were n=22 restaurants who replied that the scallops are already shucked. Although it might be possible that these shucked scallops have only the adductor meat, we cannot be sure, and therefore these 22 have been excluded from the table below.

Exploring this in more detail restaurateurs were asked what they did with the roe/gonad if they didn't throw it away. The majority of those interviewed said they served the roe – 84% overall, ranging from 71% in France to 99% in Spain. It was also included in other dishes such as stock by many outlets. Note that these percentages add to more than 100% because restaurateurs were being questioned about their overall behaviour, not about a specific dish. Therefore they may serve the roe/gonad to be eaten for some dishes, but keep it back for using in a stock or sauce for other dishes.

However while the roe/gonad was generally served it was not always eaten. Overall, 27% of customers who were given the opportunity to consume the roe/gonad returned it uneaten. This ranged from 7% in France to 66% in Spain. .

Table 25: Number of restaurants serving roe/gonad to be eaten

Country	Number and % of outlets serving roe/gonad*
Overall	**366(84%)**
UK	78(80%)
SP	99(99%)
IT	89(94%)
FR	71(71%)
BE	29(64%)

Source: Q6a and Q6b

**67 restaurants (55 Belgian, 5 Italian, 7 UK) did not record data for this item.*
Note that the percentages for served and included in stock do not add up to 100 – in fact, of the 504-67 = 437 restaurants who replied to this question, 340 of the 360 who served the roe/gonad only served this, 71 of the 97 who used it as stock only used it as stock, and the remaining 26 reported both serving the roe/gonad and using it as stock.

Overall, it can be concluded therefore that if 84% of restaurants serve the roe/gonad, and on average, in 27% of cases the roe is returned uneaten, 61% (84%*(100-27)%) of restaurant consumers are potentially eating the roe/gonad. Up to an additional 22% of restaurants included the roe/gonad in a stock or a sauce.

Table 26: Percentage of customers returning roe/gonad uneaten

Country	Number of restaurants returning data	% of customers (mean, SD) returning roe/ gonad uneaten
Overall	**321**	**27(40)**
UK	**55**	16(20)
SP	**99**	25(42)
IT	**68**	66(45)
FR	**71**	7(13)
BE	**28**	17(27)

Table 27: Number of restaurants including roe/gonad as a sauce or a stock

Country	Number and % of outlets including roe/gonad in other food e.g. as stock
Overall	**97(22%)**
UK	27(28%)
SP	1(1%)
IT	11(12%)
FR	39(39%)
BE	19(42%)

Main cooking methods used

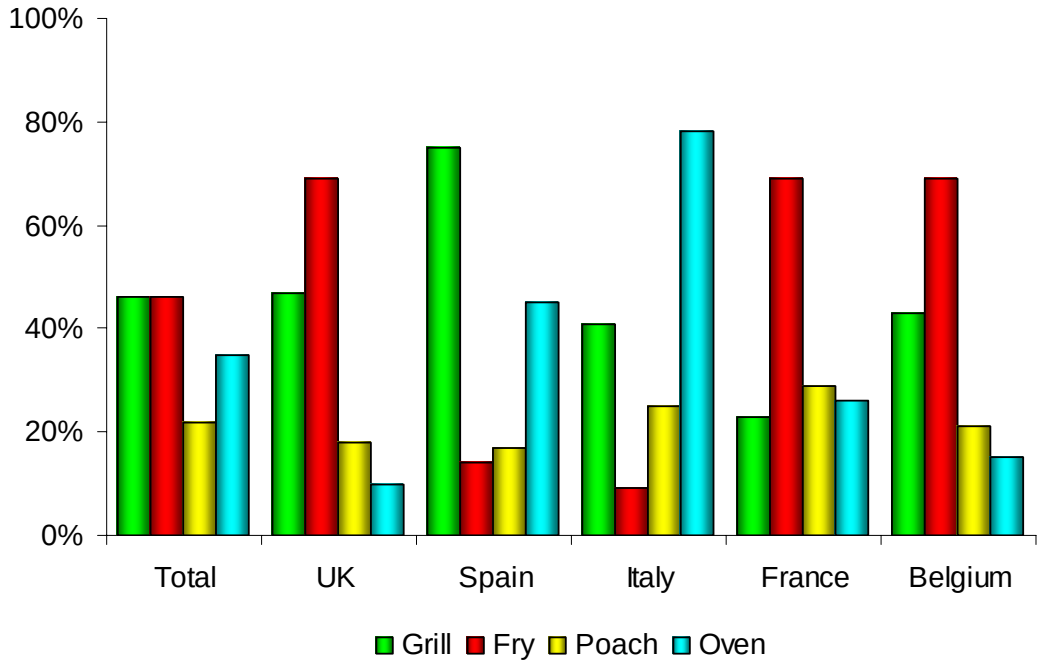
There was some similarity evident in the cooking methods used by respondents purchasing scallops for in home preparation and by restaurateurs for serving to consumers out of home. For example where both types of eating occasions were concerned, in the UK and France frying was used most frequently both in and out of home to cook scallops, as was grilling in Spain and oven baking in Italy.

Table 28: Main cooking methods used in the preparation of scallops

Country	Grill[1]	Fry[2]	Poach[3]	Oven[4]
Overall	**231(46%)**	**233(46%)**	**111(22%)**	**174(35%)**
UK	49(47%)	72(69%)	19(18%)	10(10%)
SP	75(75%)	14(14%)	17917%)	45(45%)
IT	41(41%)	9(9%)	25(25%)	78(78%)
FR	23(23%)	69(69%)	29(29%)	26(26%)
BE	43(43%)	69(69%)	21(21%)	15(15%)

Source: Q7
Note that the percentages are not constrained to sum to 100 i.e. more than 1 cooking method is allowed in the response.
[1] *Grill, Barbecue, Seared, Char-grilled, Griddle*
[2] *Fry, Pan-fried, Stir-fried, Sautéed*
[3] *Poach, In stock, boiled, steamed*
[4] *Oven Bake*

Figure 14: Main cooking methods used in the preparation of scallops



4.7. Section 2 - Consumer level analysis

In section one a model incorporating consumer variables was used to estimate the average portion size and weights for scallops consumed in home across the five European countries under study.

The interviewing of restaurateurs generated detailed data on the portion sizes and weights of scallops served to consumers out of home. Estimates of average portion sizes and weights are presented in the tables below.

4.7.1. Scallop portion sizes out of home

In four out of the five countries under study scallops were more frequently consumed as starter dishes than as main courses, with starters accounting for 58% in the UK and up to 78% in Belgium. France was the only country where the majority of dishes being served were mains, with starters accounting for just 33% of total dishes.

4.7.2. Mean scallop portion size per person - starter and main combined (number of scallops)

The resulting mean portion size per person overall was 3.47, as indicated in the table below, with the median lying at 3. Similarly to the case with in home scallop consumption, significant differences existed across countries, the minimum portion size recorded being evident in Spain at 1.6, the maximum being evident in France at 4.78. An understanding of culinary traditions assists in the interpretation of this data. For example the lower average portion size in Spain may be explained by the prevalence of tapas type dishes in Spain.

Table 29: Mean scallop portion size per person - starter and main combined (number of scallops)

Country	Number of consumers	Mean portion size (number of scallops)	SD	Median	1%-tile	99th-tile
Overall	**24,340**	**3.47**	**1.95**	**3**	**1**	**8**
UK	5,829	4.26	2.11	4	1	10
SP	3,868	1.6	0.73	1	1	4
IT	4,343	2.69	1.62	2	1	7
FR	5,911	4.78	1.59	5	1	8
BE	4,388	3.09	1.28	3	1	6

Source: Q10 part e – number of scallops in portion, and Q10 part g – number of portions sold per week, and Q8 parts 1 and 2 – how many main courses, how many starter courses sold per week by the restaurant.

Note the method used to calculate the figures in this table - the number of scallops in each dish is reported exactly, but the number of portions of each dish sold is only reported in aggregate: 1-5, 6-10,11-15,16-20, 20+. In addition, the total number of starter or main portions sold by the restaurant is given. The mid-point of the aggregate reports is taken i.e. 3, 8, 13, 18, and for the unbounded upper limit of 20+, a 'midpoint' of 28 is taken. The total number of starter dishes is found for that restaurant, and then proportionately each dish is assigned a 'weekly number of portions'. For example, suppose a restaurant sold three starters, and these dishes were sold as 1-5, 16-20, and 20+ portions per week. Suppose further the restaurant declared a weekly total of 130 starter portions. Then the assigned weekly number would be: 3/(3+18+28), 18/(3+18+28), 28/(3+18+28) of 130 portions, or (rounded to nearest portion), 8, 48, and 74 portions.

4.7.3. Mean scallop portion size per person - starter (number of scallops)

Focusing on starter dishes the mean portion size falls to 2.85 overall, rising to 3.7 in the UK and falling to 1.5 for Spain.

Table 30: Mean scallop portion size – starter (number of scallops)

Country	Number of consumers	Mean portion size (number of scallops)	SD	Median (number of scallops)
Overall	**14,852**	**2.85**	**1.45**	**3**
UK	3,357	3.7	1.29	3
SP	2,825	1.5	0.72	1
IT	3,282	2.53	1.46	2
FR	1,980	3.64	1.3	3
BE	3,408	2.98	1.18	3

Source: Q10 part e – number of scallops in portion, and Q10 part g – number of portions sold per week. Method - #1.

4.7.4. Mean scallop portion size per person - main (number of scallops)

From a mean of 2.85 for starter portion sizes overall, the mean main course portion size overall rises significantly to 4.45 overall, with a high of 5.36 in France and a low of 1.89 in Spain.

Table 31: Mean scallop portion size – main (number of scallops)

Country	Number of consumers	Mean portion size (number of scallops)	SD	Median (number of scallops)
Overall	**9,488**	**4.45**	**2.2**	**5**
UK	2,472	5.01	2.7	5
SP	1,043	1.89	0.7	2
IT	1,062	3.19	1.96	3
FR	3,931	5.36	1.41	5
BE	980	3.47	1.5	3

Source: Q10 part e – number of scallops in portion, and Q10 part g – number of portions sold per week. Method - #1.

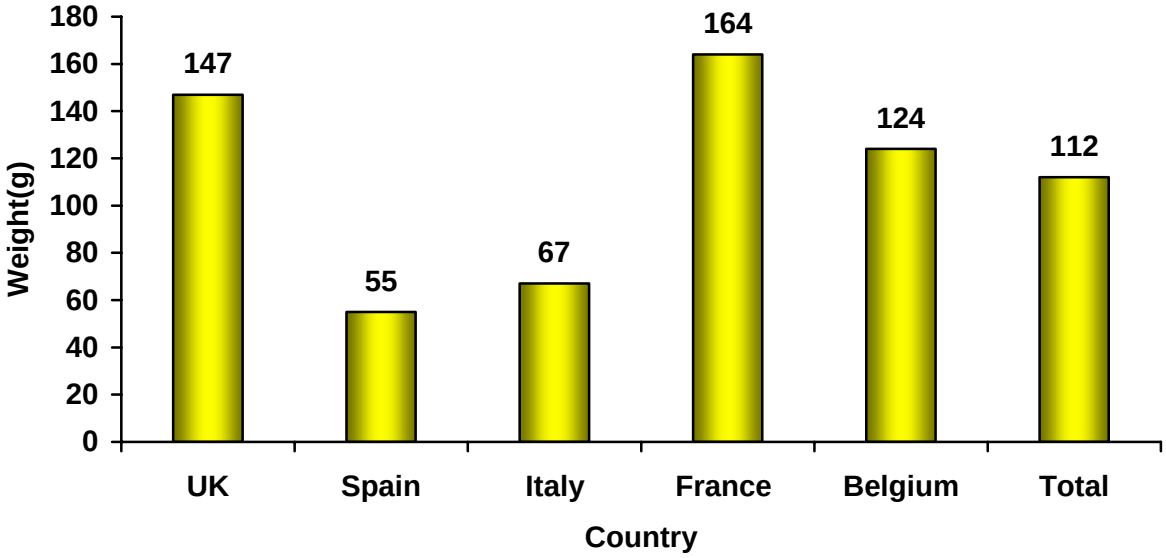
4.7.5. Simulation study for the weights of restaurant portions

Simulation studies with the same structure as for the retail study were performed for the restaurant data, but using the laboratory measured scallop weights for samples collected from restaurants rather than retail outlets.

Table 32: Restaurant portion weights

Restaurant	N	Mean	SD	Median	1st percentile	99th percentile
UK	5829	147	77	133	26	396
Spain	3868	55	30	49	14	157
Italy	4343	67	40	57	5	201
France	5911	164	59	165	47	301
Belgium	4388	124	57	116	29	280
Overall Restaurant	**23340**	**112**	**54**	**104**	**24**	**267**

Figure 15: Restaurant portion weights



All the pair wise differences between the countries were significant at P<0.0001 using two sample t-tests assuming equal variance for both countries.

4.8. Conclusion

In conclusion, combining the two sources (in home and restaurant) the average weight for a notional scallop portion across the EU is approximately 100g, only 40% of the assumed figure of 250g.

Substantial variability was observed across countries, with portion weights in Spain and Italy considerably lower than the UK and France, and Belgium somewhere between these. The heaviest portions on average are served in France, but even at an average of 164g – out of home - this is still only 66% of the assumed 250g average weight.

The 2001 statement on Amnesic Shellfish Poisoning issued by the Committee on Toxicology highlighted the importance of obtaining additional data on the consumption of scallops to the determination of threshold levels. This report represents an important piece of the jigsaw in the discussion of threshold levels in providing intelligence on the purchase and consumption of scallops across five European countries. The findings and statistical approach will also have a valuable contribution to make to the planning and interpretation of future toxicological studies

Appendix 1 – Committee on Toxicity of Chemicals in Food Consumer Products and the Environment

STATEMENT ON AMNESIC SHELLFISH POISONING

Introduction

1. We have been asked by the Food Standards Agency to review the issue of amnesic shellfish poisoning (ASP). The Committee was asked to consider whether the current EU action limit for bivalve shellfish (e.g. mussels, scallops, clams) of 20μg domoic acid/g tissue is adequate for the protection of public health. The Committee was also asked to comment on the public health implications of a proposed tired approach to scallop harvesting. This approach would allow harvesting of individual organs from whole scallops containing above 20μg domoic acid/g tissue. The individual organs could be marketed only if they contain levels less than or equal to 20μg domoic acid/g tissue.

Background

2. Amnesic shellfish poisoning was first recorded in Canada in 1987 following the consumption of contaminated mussels. Approximately 150 people became ill, and the outbreak resulted in the hospitalisation of 19 people and 4 deaths. The clinical effects were caused by domoic acid (figure 1), a water-soluble, amino acid which is produced by species of *Pseudonitzschia* phytoplankton, and accumulated by shellfish[1,2].

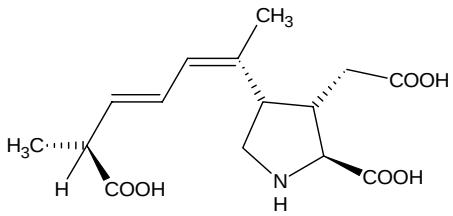


Figure 1: Chemical structure of domoic acid

3. Following the outbreak, the Canadian authorities imposed an action limit in mussels of 20 μg domoic acid/g tissue, above which harvesting of shellfish was suspended. The EU adopted this action limit for mussels and other bivalve shellfish including scallops and clams in 1997 (EC Directive 97/61/EC).

Toxicology

4. We reviewed the published toxicological data from animal studies and human case reports. There are limited data on the absorption, distribution, metabolism and excretion of domoic acid. However, these data indicate that domoic acid is not well absorbed in rodents and primates[3,4] and undergoes little metabolism prior to rapid excretion[5]. These data indicate species differences following oral exposure and suggest that primates have a relatively high sensitivity compared with rodents[4,6].

5. Domoic acid is a glutamate receptor agonist and binds with particularly high affinity to glutamate receptors in the central nervous system[7]. It is an excitotoxin and can produce a range of neuro-behavioural effects, which appear to be the most sensitive indicator of domoic acid toxicity.

6. Domoic acid is neurotoxic causing neuronal degeneration and apoptosis in specific regions of the hippocampus[8,9]. The lesions induced are consistent between rodent[11,12,13] and primate studies[6,14] and human[15,16] cases of ASP. Several mechanisms are thought to mediate the neurotoxicity. These involve perturbation of secondary messengers, including calcium and protein kinase C. However, it is thought that the critical toxic insult is the excessive accumulation of intracellular calcium[10].

7. The data indicate that rodent neonates are more susceptible to domoic acid toxicity than adults[17].

8. In rodent neonates, the spinal cord appears to be more sensitive than the brain to domoic acid toxicity[17]. However, a parallel comparison has not been carried out in adult rodents.

9. Domoic acid was not mutagenic *in vitro* in *V79* cells[18], but has not been tested in other systems. As there is potential for epoxide formation, it is suggested that further information on mutagenicity is required.

10. From review of the animal studies, we conclude that many used small group sizes and were inadequately reported. Additionally, many studies tested contaminated shellfish extract rather than purified domoic acid. This limited the utility of these studies, as the domoic acid content was not accurately quantified and the presence of other toxic components could not be excluded. Therefore, we consider the data were insufficient to identify a no-observed adverse effect level (NOAEL) or lowest-observed adverse effect level (LOAEL) which could support derivation of a Tolerable Daily Intake (TDI).

Human data

11. We reviewed the published case reports from two major outbreaks of ASP[1,2]. The most serious outbreak resulted in approximately 150 reported cases of ASP, the hospitalisation of 19 people and 4 deaths. The clinical symptoms ranged from gastrointestinal (GI) effects, to neurotoxic effects such as hallucinations, memory loss and

coma. GI disturbances appeared within 24 hours and neurological effects within 48 hours of consumption of contaminated

12. It has been suggested that the elderly are particularly vulnerable to ASP as the reported deaths occurred in individuals over 70 years of age. However, we are unconvinced that these limited data support such a premise as co-morbidity present in this group may have contributed to the deaths[1,2]. We note there are no data on the susceptibility of infants or children to ASP.

13. Although there have been no recorded outbreaks of ASP in the UK, we recognise that food poisoning incidents are under-reported. We note that the symptomology and rapid elimination of domoic acid from the body make ASP difficult to verify clinically. However, we suggest that urinary domoic acid may serve as a potential biomarker of exposure to this toxin but only if analysed soon after ingestion.

14. Due to the limited data, we were unable to ascertain if the GI disturbances were direct effects of domoic acid or a manifestation of excitotoxicity in the central nervous system. The latter is a plausible mechanism although it does not preclude the possibility of direct effects occurring in tandem. We regard neurotoxicity as the most significant effect of ASP in terms of public health.

Action Limit

15. We note that the current action limit is based on consumption estimates from the 1987 Canadian ASP outbreak indicating that mussels contaminated with ≥200μg/g domoic acid resulted in human illness. However, this was a retrospective estimate from a small number of affected individuals. A ten-fold uncertainty factor was incorporated to give an action limit of 20 μg/g[19,20]. The EU subsequently applied this action limit to other bivalve shellfish.

16. We regard the action limit as a pragmatic guideline rather than a toxicologically based safety limit. As noted in paragraph 10, the available data are not adequate to identify a NOAEL or LOAEL. In view of the severe and potentially irreversible neurotoxicity of domoic acid, we consider that an uncertainty factor of 10 is inadequate to allow for inter-individual variability in addition to the uncertainties in the estimation of the domoic acid content and quantity of mussels consumed. However, we consider that at present the toxicological and shellfish consumption data are too limited to support derivation of an alternative action limit. We suggest that further long-term toxicological studies are conducted, using appropriate models. Additional information on shellfish consumption is required to allow derivation of a TDI and a more robust action limit.

Tiered approach

17. Currently, EU directive 97/61/EC prescribes an action level for domoic acid of 20 μg domoic acid/g tissue for bivalve shellfish. If concentrations exceed this, harvesting of shellfish is stopped until levels drop below this. Detection of domoic acid in a range of

shellfish, in particular King Scallops, has resulted in the frequent closure of harvesting grounds in Scotland.

18. The Food Standards Agency in Scotland is investigating a tiered approach to harvesting. This approach would allow harvesting of individual organs from whole scallops containing above 20 μg domoic acid/g tissue. The individual organs could be marketed only if they contain less than or equal to 20 μg domoic acid/g tissue.

19. The accumulation of domoic acid in shellfish is unpredictable, as very little is known about the environmental conditions that trigger phytoplankton blooms and the consequent production of domoic acid. There is also considerable inter-scallop and inter-organ variability in concentrations of domoic acid. Additionally, cross-contamination can occur during processing. We have paid particular attention to these factors in considering the public health implications of ASP.

20. In order to ensure adequate protection of public health we advise that shellfish and shellfish parts at point of sale should not exceed the current action limit. Therefore, we recommend that rigorous monitoring and enforcement at point of sale is incorporated into a tiered approach, if introduced. This is essential to account for the:

- unpredictable nature of domoic acid contamination of shellfish,
- considerable variability in the inter-scallop and inter-organ concentrations of domoic acid,
- possibility of cross-contamination during processing,
- pragmatic nature of the action limit,
- risk of irreversible neurotoxicity.

Conclusions

21. We *consider* there are important and severe public health implications of ASP due to the irreversible neurotoxicity of domoic acid.

22. We have reviewed the toxicological data on domoic acid but *consider* these insufficient to establish a NOAEL that is appropriate for regulatory purposes. This is a reflection of the paucity of these data rather than the absence of harm. We *suggest* that if a TDI is to be established further toxicological studies using appropriate animal models are required.

23. In view of the small margin of safety between the current action limit of 20 μg domoic acid/g tissue and the concentration of domoic acid resulting in human illness we *consider* this limit as a pragmatic guideline and not a toxicologically based safety limit. We *advise* that shellfish at point of sale should not exceed the current action limit.

24. We *strongly recommend* that if a tiered approach is introduced it will require rigorous monitoring at point of sale and enforcement to ensure protection of public health.

25. We *consider* that more information on shellfish consumption is required.

26. We *note* that to date, there have been no reports of ASP in the UK and therefore, the current action limit may protect against major outbreaks. However, we *recognise* that in general, food poisoning incidents are under reported.

November 2001
COT Statement 2001/08

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Appendix 2 - Integrin Scallop Weight Study

From a selection of the restaurants and retail outlets (ten of each per country was the target) a sample of ten scallops with gonad attached were bought and sent to Integrin Laboratories in Scotland for scientific weighing of both the adductor muscle and the roe/gonad.

Percentage moisture content of samples

The analyses below reports the findings for moisture content (% water by weight) for the 91 samples of ten collected, and then the distribution of the weight of the adductor muscle, and the gonad/roe, and then the % of total weight (that is, adductor plus roe/gonad) that the roe/gonad comprised.

Table 1: Percentage moisture content of samples

Factor	Level	N	Mean	SD	Min	5%	10%	25%	50%	75%	90%	95%	100%
Overall		**91**	**78.7**	**3**	**67.7**	**75.2**	**75.5**	**76.8**	**78.5**	**80.4**	**82.4**	**85.5**	**86.1**
Country	UK	18	77.8	2.1	73.7	73.7	74.6	76.6	78.2	78.6	81.2	82.3	82.3
	SP	15	81.7	3.15	77	77	78.6	78.8	81.8	85.5	85.7	86.1	86.1
	IT	20	78.7	2.21	74.3	74.7	75.2	77.1	79	80.5	81	81.7	82.4
	FR	19	76.9	2.76	67.6	67.6	75.5	75.9	77.1	78.6	79.6	81.5	81.5
	BE	19	78.9	3.08	75.4	75.4	75.6	76.9	77.6	81.4	84.7	85.8	85.8

The differences between countries were significant at P<0.0001 (F-test). There was no evidence of an interaction between restaurant/retail status and country for moisture content (P-for-interaction=0.47), and also restaurants/retail status was not significant as a main effect (P=0.87)

For each of the following tables – for adductor muscle, gonad/roe, and total weight, and for gonad/roe to total as a percentage, there are significant (P<0.0001) interactions between restaurant/retail status and country. The data for retail outlets and then restaurants is reported separately in later tables.

Table 2: Adductor muscle weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**910**	**27.5**	**9.7**	**3.2**	**7.5**	**16**	**21.1**	**26.9**	**32.8**	**39.7**	**54.4**	**64.1**
Country	UK	180	30	10	9.9	12.5	18	23	28.6	36.7	44.1	55	58.6
	SP	150	25.7	9.6	11.2	11.7	14.2	17.3	25.3	32.1	37.6	49.5	64.1
	IT	200	23.5	9.7	3.2	4.2	9.4	17.2	23.4	29.1	36.5	50.3	60
	FR	190	28.4	9.1	8	10.8	16.9	22.2	27.6	32.9	40.7	52.5	54.4
	BE	190	29.7	8.5	12.8	14.2	19.4	24.7	29.1	33.3	37.9	58	59

Table 3: Gonad/roe weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		910	6.22	4.87	0	0.23	1.7	3.04	4.96	8.02	12.1	25.4	38.9
Country	UK	180	5.43	4.63	0	0	1.62	2.52	4.04	6.75	11	27.6	29.8
	SP	150	8.63	6.13	0.34	0.52	2.6	4.59	7.06	11.3	17.1	27.6	38.9
	IT	200	5.18	3.42	0.17	0.2	1.64	3	4.54	6.66	8.78	15.8	26.4
	FR	190	4.63	3.42	0	0	1.34	2.2	3.54	6.38	9.57	15.7	19.7
	BE	190	7.74	5.35	0.43	0.74	2.92	4.37	6.3	9.32	13.1	27.6	28.9

Table 4: Total weight (adductor plus gonad) – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**910**	**33.7**	**12.5**	**3.4**	**9.4**	**18.9**	**25.3**	**32.7**	**40.3**	**49.3**	**73.2**	**86.5**
Country	UK	180	35.4	12.2	12.9	13.4	21.9	26.6	33.2	43.1	51.1	78.8	79.1
	SP	150	34.4	12.8	13	13.9	18.1	22.8	34.2	43.8	52.6	66.5	71.6
	IT	200	28.7	12.1	3.4	5.1	14	20.6	28.1	35.5	44.2	61.7	86.5
	FR	190	33	11.2	11.4	14.5	19.3	25.2	32.3	38.5	49.9	63.2	65.8
	BE	190	37.5	12.7	13.9	16.5	23.4	31.1	35.5	42.3	50	81.4	81.9

Table 5: Gonad/roe: total weight ratio as a percentage – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		910	17.5	9.3	0	2.6	6.4	10.1	16.1	23.3	30.9	42	58.8
Country	UK	180	14.7	8.8	0	0	6	8.2	12.5	19.1	30.1	37.8	38.4
	SP	150	23.8	11.3	2.3	2.6	9.8	15.4	23	32.1	38	58.5	58.8
	IT	200	17.6	8	2.6	3.5	6.4	12.5	16.9	22.7	28	37	42
	FR	190	13.4	7.7	0	0	5.4	8.2	11.7	17.3	25	36.9	43.1
	BE	190	19.3	7.8	2.6	2.7	8.7	13.6	19.1	25	29.2	38.7	40.8

RETAIL OUTLETS ONLY

Table 6: Adductor muscle weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**300**	**27.4**	**8.2**	**13.3**	**13.7**	**17.5**	**21.6**	**26.2**	**31.6**	**37.8**	**50.7**	**60**
Country	UK	50	30.1	8.8	13.3	13.3	19.8	23	30.5	35.1	39.5	51.2	51.2
	SP	No retail outlet data collected in Spain											
	IT	100	26.8	8.1	13.5	13.7	16.9	21.6	25	31.2	37.4	55.2	60
	FR	80	26.9	9.3	13.3	13.3	16.6	19.2	25.2	31.5	40.4	51	51
	BE	70	26.7	6.3	14.2	14.2	19.2	22.1	26.7	30.3	35.2	48.4	48.4

Between country differences P=0.088

Table 7: Gonad/roe weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**300**	**5.6**	**4.1**	**0**	**0**	**1.53**	**2.94**	**4.65**	**7.44**	**10.3**	**23.1**	**29.8**
Country	UK	50	7.1	5.88	1.09	1.09	1.64	3.17	5.17	10.1	13.5	29.8	29.8
	SP	No retail outlet data collected in Spain											
	IT	100	5.58	3.81	0.65	0.94	2.07	3.17	4.65	6.84	8.78	21.2	26.4
	FR	80	4.28	3.94	0	0	0.81	1.57	2.87	5.9	9.27	19.7	19.7
	BE	70	6.06	2.38	0.84	0.84	3.26	4.22	5.74	7.72	9.29	12.2	12.2

Between country differences P=0.001

Table 8: Total weight (adductor plus gonad) – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**300**	**33**	**11.2**	**14.5**	**16.4**	**20.4**	**25.2**	**31.4**	**38.8**	**47.6**	**72.4**	**86.5**
Country	UK	50	37.2	13.6	16.8	16.8	22	28.2	35.6	43.7	51.1	79.1	79.1
	SP	No retail outlet data collected in Spain											
	IT	100	32.4	11.1	16.5	16.8	20.1	25.3	29.9	37.1	46.3	76.2	86.5
	FR	80	31.2	12.2	14.5	14.5	18.1	21.3	27.8	36.3	50.6	60.6	60.6
	BE	70	32.8	7.1	20.3	20.3	23	26.5	32.4	38.9	42.1	52.6	52.6

Country differences P=0.024

RESTAURANTS ONLY

Table 9: Adductor muscle weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**610**	**27.5**	**10.3**	**3.2**	**6.8**	**14.8**	**20.1**	**27.4**	**33.2**	**40.7**	**54.7**	**64.1**
Country	UK	130	29.9	10.4	9.9	12.5	17.6	23	27.4	37	45	55	58.6
	SP	150	25.7	9.6	11.2	11.7	14.2	17.3	25.3	32.1	37.6	49.5	64.1
	IT	100	20.3	10.1	3.2	3.4	7.5	11.3	19.9	27.3	33.5	47.2	50.2
	FR	110	29.5	8.8	8	10.8	19	24.1	29.2	33.3	41.3	52.5	54.4
	BE	120	31.5	9.1	12.8	14.8	19.7	27.1	30.2	35.3	44.6	58	59

Country differences P<0.0001

Table 10: Gonad/roe weight – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**610**	**6.52**	**5.18**	**0**	**0.33**	**1.81**	**3.08**	**5.13**	**8.37**	**12.9**	**25.4**	**38.9**
Country	UK	130	4.78	3.89	0	0	1.62	2.42	3.74	5.45	9.2	21.1	24.7
	SP	150	8.63	6.13	0.34	0.52	2.66	4.59	7.06	11.3	17.1	27.7	38.9
	IT	100	4.78	2.94	0.17	0.17	0.86	2.67	4.41	6.47	8.8	13	13.4
	FR	110	4.88	2.98	0.93	1.07	1.9	2.8	3.98	6.42	9.71	12	15.7
	BE	120	8.73	6.29	0.43	0.74	2.3	4.39	7.4	11.7	18.1	27.6	28.9

Country differences P<0.0001

Table 11: Total weight (adductor plus gonad) – individual scallops

Factor	Level	N	Mean	SD	Min	1%	10%	25%	50%	75%	90%	99%	100%
Overall		**610**	**34.1**	**13.2**	**3.4**	**7**	**18**	**25.3**	**33.2**	**41.5**	**50.4**	**73.2**	**81.9**
Country	UK	130	34.7	11.8	12.9	13.4	21.9	26.2	32.4	42.3	51	66.6	68.6
	SP	150	34.3	12.8	13	13.9	18.1	22.8	34.2	43.8	52.6	66.5	71.6
	IT	100	25	12	3.4	4.1	9.4	16.6	24	33.8	40.5	55.1	57.2
	FR	110	34.4	10.3	11.4	14.8	22.5	27.9	33.1	39.3	49.4	63.2	65.8
	BE	120	40.3	14.4	13.9	16.5	25	32.5	37.4	44.7	59.6	81.4	81.9

Country differences P<0.0001