Simulated Recalls of Food Products

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ABSTRACT

Much of the food that reaches the modern consumers plate is sourced globally. Production and distribution patterns have become much more complex than was common even a quarter of a century ago and consumer preferences have evolved to include specialist foods and foods out of season. At the same time both the number and type of food related human health incidents, from Bovine Spongiform Encephalopathy (BSE) to Dioxins, are growing. When these two factors are combined the need for greater transparency in food supply chains becomes apparent as an increasing number of recalls are carried out. Creating this transparency requires the ability to trace and track ingredients in food stuff rapidly and precisely. This study intended to test a number of hypothesis related to the effectiveness of recalls within five different food sectors. In order to do this a simulated recall was carried out. In total it was possible to trace 53 % of the product bought back through their supply chains to their origin.

KEYWORDS Simulated Recall, Tracking, Tracing, Traceability, Food

INTRODUCTION

Much of the food that reaches the modern consumers plate is sourced globally. Production and distribution patterns have become much more complex than was common even 30 years ago and consumer preferences have evolved to include specialist foods and foods out of season (Skees, Botts and Zeuli, 2001). At the same time the number and types of food related health incidents, from Bovine Spongiform Encephalopathy (BSE) to Dioxins, are growing (Carriquiry and Babcock, 2007; Caswell, 2000; Elbers, Moser, Ekker, Crauwels, Stegeman *et al.*, 2001; Fallon, 2001; Hobbs, 2004; Madec, Geers, Vesseur, Kjeldsen and Blaha, 2001; Ozawa, Ong and An, 2001; Sporleder and Goldsmith, 2001). These factors have contributed to a need for greater transparency in food supply chains. (Carriquiry and Babcock, 2007; Inman, 2009; Kiesel, Buschena and Smith, 2005; Pettitt, 2001). Creating this transparency requires the ability to trace and track ingredients in food stuff rapidly and precisely.

European Union (EU) food law (Anon, 2002a; Anon, 2002b; Schwägele, 2005) states that the operator must record both receipt and despatch of ingredients. However there is no requirement to record either transformations of the Traceable Units (TU's) that take place within a company or to have internal traceability systems. In the food sector transformations, especially mixing, have been shown to be important points of information loss (Donnelly, K.A.-M., Karlsen and Olsen, 2009). Without internal traceability it can be difficult to connect specific products received to those delivered, which is essential when tracing specific food products. In contrast to the EU the United States of America (USA) has introduced legal requirements regarding internal traceability (Anon, 2002a).

Research carried out by Teratanavat and Hooker (2004) in the USA concluded that the number of recall incidents related to food products has been increasing since 1997. In the same paper they show that the recovery rate is unchanged. This would suggest that research is required into the food sector recall methods including identification of best practise and the reasons for the lack of increasing precision. There is little if any research with regards to food recalls that has been presented within the EU, the authors hope that this paper will contribute to filling this gap. Research in this area is also important for economic reasons. Numerous studies have shown that serious recalls have a negative affect on company profits. Kramer, Coto and Weidner (2005) Skees, Bottsamda and Zeuli (2001) and Thomsen and McKenzie (2001) have shown that the most serious type of recalls reduces shareholder wealth by a magnitude of 1.5-3%. Studies in the automobile and pharmaceutical sectors have also shown that product recalls have a negative effect on share prices. (Dranove and Olsen, 1994; Jarrell and Peltzman, 1985; Thomsen and McKenzie, 2001).

Effective tracking and tracing systems improve the speed and precision of recalls both in life threatening food contamination issues and also in less serious food quality issues. The less precise a company is when recalling products the greater the publicity they need for it to be effective resulting in greater economic consequences. Important factors effecting speed and precision of tracing and tracking are batch size and degree of granularity. The smaller the recorded batch size the greater the precision that is possible in the traceability process (Bertolini, Bevilacqua and Massini, 2006).

The results of the authors study together with others such as Karlsen and Senneset (2006) and Randrup et al. (2008) provide a picture of the progress of the food industry in implementing traceability initiatives. The time span for these studies is limited (2006 to 2008). These other studies related exclusively to fish sourced in the Nordic countries.

Previous studies in this area have highlighted a number of issues which should be addressed for further research. One hypothesis put forward by a researcher working in this field (verbal contribution from Sherri McGarry at the Joint Institute for Food Safety and Applied Nutrition (JIFSAN) conference 2009) was that the shorter and simpler the supply chain the quicker and more effective recall would be. Data from a broad range of supply chains would enable this problem to be examined further. Another interesting observation is that the smaller the recorded batch size the greater the precision that is possible in the traceability process (Bertolini, Bevilacqua and Massini, 2006). It would be interesting to shed light on what optimal batch sizes are. The affect of import activities on products is also interesting, is it harder to trace a imported product? Another area of interest epically related to fish products is whether there are any differences between products based on farmed or wild caught raw materials. In the study carried out by Levinson (2009) water, dairy (including eggs), grain and produce (fruit and veg) it was found that 4 out of the 12 diary products were traceable and one of the water products was traceable where as Karlsen and Senneset (2006) report that they were able to trace 63% of the chosen fish products back to one boat or fish farm while in 2008, (Randrup *et al.*, 2008) were able to trace 56% of the products investigated back to one boat or fish farm. This could suggest that simple products which have the least ingredients are more easily traced. These hypotheses need further empirical testing.

The aims of this study were to investigate the current reactions in the food production sectors to a possible recall and to gather data about recall times and batch sizes from across a number of sectors.

This was to allow comparison within one geographic region as well as between individual sectors within that region. This is an important extension to work which has previously been carried out in the fish sector. The result of this work should enable more focused and appropriate research both for the authorities and for the various food sectors into improving both precision of and time taken for food recall.

METHOD

A modified version of the method described by Karlsen and Senneset (2006) and Randrup et al. (2008) was used and is briefly outlined in fig.1. Food products were bought at selected larger supermarkets. In order to guard against bias in the results randomised decisions were made with regards to which products should be bought and where. Three large populated areas spread across the geographic area under investigation were chosen, these were: the Norwegian cities of Oslo, Trondheim and Tromsø. It was decided that 6 supermarkets would be visited at each location. In each supermarket 2 products would be bought, with care taken not to buy the same product in the same supermarkets, at the different locations. This would avoid the study replicating results in the same supply chain. A structured interview was used in each shop and each business involved in the supply of the product. The interview questions can be seen in tab. 1. The same protocol with regards to instructions to shop employees was followed in each supermarket.

Figure 1.

Following the initial purchase of products the researchers immediately began contacting each link of the supply chain through which the products had travelled using the structured interview which was used in the supermarkets with some additional questions (shown in tables 1 and 2). All contacts were recorded and registered in a data base for analysis.

Table 1.

The additional questions which were used in the telephone interviews can be seen in table 2.

Table 2.

The data collected was analysed using Microsoft Excel and SPSS (Statistical Package for the Social Sciences).

RESULTS AND DISCUSSION

This study provides new insight into the production and distribution patterns of some of the food stuffs that consumers have become used to in the last 30 years. During this period food related health incidents, from BSE to Dioxins have become a growing concern, this could be due to increased global trade and the increased complexity of food products (de Matos, Ituassu and Rossi, 2007). As far as the authors are aware this is the first data set which presents a systematic comparative study of recall times for commonly bought consumer food stuffs. Transparency and increased information capture throughout the food chain is necessary because studies such as that presented by Vierk, Falci, Wolyniak and Klontz (2002) have shown that in the USA the 96% of recalls (in the period studied) were labelling errors carried out during production of food stuffs. This clearly shows that it is important, particularly for processed products, to acquire information throughout the supply chain and be able to trace throughout a supply chain (Levinson, 2009). The best practise for handling recalls should be long term and cross functional (Kumar and Budin, 2006).

Table 3.

Each of the sectors investigated comply, as far as we are able to ascertain, with the current 'one up one down' EU regulation (Anon, 2002b). This regulation requires as a minimum the ability to establish what type of product is supplied from which suppliers and what type of product is sold to which customers. It is clear from the results of this study that the fastest and most precise tracing activities were achieved when a supply chain has addressed both internal and chain traceability and had clear connections between internal traceability data and chain traceability data.

Figure 2.

Supply chain length

It can be seen from the results that the longest supply chains were on average encountered in the fish sector. The longest fish sector supply chain was 9 links (tab.4).

Table 4.

Generally the farmed fish chains had the most links and 67% of the fish bought in these supply chains were traceable back to a specified source. One hypothesis which it was hoped could be tested here was that the shorter and simpler the supply chain the quicker and more effective recall would be (Sheri McGary). The results from this study do not support this seemingly logical theory. For example the results for the fish products show that although they had one of the highest numbers of links in a supply chain (varying from 7-9 see tab 4) the fish sector was also characterised by a relatively high percentage of known origins (67%). Unprocessed products such as the fruit and vegetables had a lower percentage with a known origin (50%) and a supply chain of only 3-4 links see tab 5.

Table 5.

From the evidence in this survey we can see that there was no such trend towards shorter supply chains leading to faster recall times. The authors suggest that other factors, such as company motivation and customer demands, play an important role in the amount of effort put into effective tracing and tracking systems.

Batch size

The batch size is an important factor in relation to traceability. If no internal traceability information is registered, such as date of use, this can lead to apparently extremely large batch sizes, of possibly a whole year or more. For example if a company has a single large delivery of salt which is used as in small quantities in production without registering either the date when they start or stop using it, the batch size (affected by a problem with the salt) can only be calculated from its date of delivery which maybe months different from its date of use. If that company then needs to recall products containing some of this salt all products from the date of the initial delivery of the salt to the present must be recalled (Donnelly, K.A. and Karlsen, 2010). This will have much greater economic consequences for the company due to the information being homogenous and imprecise. In the event of a food safety incident at any point in the supply chain there would be no possibility of carrying out a swift precision recall. During this study it was often observed that companies with multiple registrations within production could trace more precisely.

Farmed vs wild caught

It is interesting to examine whether the data shows anything regarding the difference between products which are farmed and those which are harvested. The obvious data from this study is that presented in table 4 from the fisheries sector. There are three representatives from the harvested sector and the three from the farmed sector. From what can be seen in this study there is no difference however the data set here is not large enough to draw any conclusions from. The authors might hypothesise that farmed products are easier to control than harvested ones.

Complex vs simple

None of the 'cereal' products were fully traceable. Very often the cereal was traceable back to a cereal silo but at this point there were either no records kept or the companies were not prepared to make their records public.

Table 6.

The particular problem experienced by the cereal industry is the nature of the many deliveries made to a cereal silo in a short period of time with no requirement or particular need to separate one delivery from the next (Thakur and Hurburgh, 2009). This means that there is no cut off point with a natural 'stop' at which registrations of contributing farmers can be made, the opinion is often expressed that grain is a low risk product. It is interesting to compare the grain sector to the dairy sector which is

Table 7.

similar in that a lot of deliveries are made to one container from different farms. However in contrast in the diary sector the tanks have to be cleaned regularly and frequently thus providing many 'stop' points where information about what makes up a single delivery can be registered. The dairy sector generated the best traceable result here (83%) see table 7. The authors believe that this is due both to the previously mentioned 'stop' points (in production caused by hygiene regulations) and also to the fact that the supply chain for these products moved outside the country of investigation in only one case. Additionally the attitude of managers and employees in the dairy sector, measured by their level of response, generally seemed to be positive to the idea of tracing and electronic systems were in place and well integrated.

Table 8.

Red meat may be considered a 'simple' product with the exception of the salami and the ham. The products examined here are not complex processed products or mixed products such as the grain. But even here we find that there is a long trace time and that the final batch size is relatively large. In this study there seemed to be no relationship between the complexity of the product and the ability to trace it.

In order to examine the problem of complex v's simple in depth product would need to be chosen and tested. Rather than choosing product which reflects one component complex products could be chosen and tested, for example muesli and yoghurt product or a pre marinated meat product.

Import vs local

Over 30% of the products studied here were imported into Norway before sale. This presented some problems and opportunities when gathering data as companies became less inclined to cooperate with the research once we moved outside Norway. In order to compensate for this the study was designed with the possibility to report that the product was either of known, unknown origin or not reporting this prevented the results from being skewed by the lack of responses from certain industry actors. However it also meant we were able to get an indication about whether nationally produced food is easier to trace than internationally produced food. The highest percentage of products with a known origin, without a restricted batch size was found to be in the dairy sector (tab. 7). 83% percent of the dairy products could be traced back to a known origin. Five out of the six tested dairy products were produced and processed nationally. This idea is supported by the results from the fisheries sector the where 3 of the 4 traceable products were also nationally produced and processed. In order to investigate this further a cross national study would need to be carried out in order to limit the bias towards national products experienced in this study.

Related Studies

A comparison of the results from this study with those from a study carried out within the USA (Levinson, 2009). This USA study appears to have been carried out shortly after or concurrently with the one presented here. The methodology is very similar, and therefore very interesting for the purpose of comparison. The one major difference is that the American study stops at their border.

Figure 3. Comparison of data from the study with data from an American study (Levinson, 2009).

Fig. 3 shows an overview of the results from the USA study and from the current European study. Within the limited scope of these two studies fig. 3 would seem to indicate that there is a much greater chance of locating the origin of a European food stuff than an American one. The results in the USA study show a similarity to the study carried out in Europe. In both cases most traceable products were in the dairy products group.

One interesting comment made by Levinson (2009) is that although they were able to trace only 5 of the 40 products to their origin, for 31 of the products they were able to identify which facilities were "most likely" to have handled the product they failed to trace. In our study there was only one of the products (in the fruit and veg sector) where the most 'likely route' was identified and this was due to the fact that the packaging identified the origin of the fruit. However in order to identify it on a batch and farmer level one extra identifying code was needed. This was lost because the consumer containers of the fruit were not kept in the larger cardboard box in which they were delivered. In this particular case the inability to trace back to origin was due to a lack of identification at lot and batch level. This meant that the unique identification of the Trade Units (TU), necessary for successful traceability were not locatable. These two factors highlight the need for two important things 1) companies need to be aware of how to maintain the traceability of a product – by recording all transformations and 2) The importance of internal traceability in a 'trace back' situation.

Methodological considerations

The method used here has been developed over time and through several projects. A very similar method has also been used in recent governmental studies carried out in the USA (Karlsen and Senneset, 2006; Levinson, 2009; Randrup *et al.*, 2008). The method has weaknesses which must be highlighted, these are: companies lack a sense of urgency as they are aware that this is a simulation, there is a lack of actual evidence for the claims made by the companies, (it was outside the scope of this study to physically check each company's documentation) however since details were often used from one company to the next it is thought that the likelihood of the companies misleading the researchers is negligible. 30% of the products studied here were imported into Norway before sale, as mentioned, companies in these supply chains were more disinclined to cooperate with the research.

Indicators for further research

The results of the authors' study together with others such as Karlsen and Senneset (2006) and (Randrup *et al.*, 2008) provide a picture of the progress of the food industry in implementing traceability initiatives. The time span for these studies is limited (2006 to 2008.) These other studies related exclusively to fish sourced in Scandinavia. Karlsen and Senneset (2006) report that they were able to trace 63% of the chosen fish products back to one boat or fish farm while in 2008, Randrup et al. were able to trace 56% of the products investigated back to one boat or fish farm. In the authors' study 67% of the fish products could be traced back to a fish farm or a limited number of boats. It must be borne in mind though that the studies are not directly comparable as the other studies focused on Nordic fish products and on tracing back to single vessels. The study presented here was focused on tracing multiple products from a variety of countries and traceability for the fish products did not mean tracing back to one single vessel, rather tracing to a known set of vessels. In more than one case two boats were responsible for catching the fish.

Analysis of all the data provides some useful pointers towards further study for both improving and assessing the optimal levels of traceability or information flow. These include the need for greater clarity in both identifying what is the correct information and then recording this in order to maintain identity of products (Creedle, 2007). For example one firm had recorded large amounts of internal data but had no connection to the external suppliers of ingredients making the data of little use in chain traceability. It also includes confirmation of optimal methods for harmonisation of infrastructure (Anon, 2007) for example electronic systems for registration of food product movements and compatibility of information in chain traceability systems. The data also points to the increasing need for industry standards so that multiple Information Technology (IT) solutions can be provided with systems that can 'talk to' each other (Senneset, Foras and Fremme, 2007). Research related to this is already recognised as an important area for improved and effectives information flow for example the TraceFish standards (CEN14659, 2003; CEN14660, 2003; Denton, 2003) International Organization for Standardization (ISO) work and in the honey, potatoes and chicken sectors (Donnelly, K.A., Karlsen, Olsen and Van der Roest, 2008; Donnelly, K.A., Roest, Höskuldsson, P. and K.M., 2009 ; Haverkort, 2007; Haverkort, Top and Verdenius, 2006) The final pointer being noted by (Levinson, 2009) is that of human factors and education such as an awareness of how to maintain traceability information is important.

CONCLUSION

The sector specificity of traceability challenges is only one of the new and important findings highlighted by this study. It also highlights some key features that are important for successful tracing events in all sectors. These include the registration of the specific identification of lots at reception and dispatch of food products and the marking of the smallest unit or trade unit (TU) and not least the need for companies to be aware of these basic principles of traceability. The work presented here shows that in order for sector wide traceability to be effective companies must have some degree of both internal and chain traceability. Many of the interviews carried out for this work also highlighted the fact that the development of industry or sector standards for exchange of traceability information would be beneficial. Further research is also required on assessing the cost and benefits for individual sectors of implementing varying levels of traceability.

Some of the data in this paper was included in the presentation: 'Simulated recalls of meat products, fruit and vegetables originating in the European Economic Community'. at 'TRACE in practice' the 5th TRACE conference in association with the EU project TRACE on 3 April 2009.

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TABLES

Table 1. Questions asked during the purchase of the product

Information about the purchase

1. Date of purchase
2. Place of purchase

Information about the product both on the packaging and gained in the shop

1. Describe the product.
2. Does the product have any special certifications such as MSC, KRAV, Organic?
3. Who owns the brands?
4. What is the name of the producers(contact details)

5. What is the authorisation number?
6. What is the origin of the product? (country and region)
7. In which land was the product processed
8. What is the GS1 code on the product
9. Is the product marked with any other identifying numbers?
10. What is the production date?
11. What is the ’best before’ date?
12. Is there any other information on the product?

Table 2. Questions asked as part of the structured survey

1. Which part of the value chain is this?
2. What is the name of the company and the contact person?
3. How is the information collected (in person via email , via fax via telephone)?
4. When was the information collected?
5. What was the time taken to collect information?
6. How was the information collected ?
7. Have you delivered product (specific) X to the customer Y ?
8. What kind of information can you give me about the product ?
9. Can you tell me exactly where the raw ingredients have come from?
10. Can you tell me who delivered the raw ingredients to you?
11. How large was the delivery which included the ingredients for this product?
12. How do you communicate with your customers?
13. What is the size of a batch at your company?
14. What is the estimated time needed to trace back through your company?

Table 3. Summary of the results

TYPE	KNOWN ORIGIN	UNKNOWN ORIGIN	NOT REPORTING	TOTAL INVESTIGATED	KNOWN ORIGIN (%)
DAIRY	5	0	1	6	83
FISH	4	0	2	6	67
MEAT	4	1	1	6	67
FRUIT & VEG	3	3	0	6	50
CEREAL	0	5	1	6	0
TOTAL	*16*	*9*	*5*	*30*	*53*

Table 4. Results of the simulated recall in the fish sector

PRODUCT	LAST TRACEABLE STEP	BATCH SIZE AT THIS STEP	ESTIMATED TIME TO TRACE BACK TO LAST STEP	NO OF LINKS IN SUPPLY CHAIN
SALMON FILLET	One cage at the fish farm (parental fish)	90 000 - 100 000 fish	120-180 minutes	7
FISH PIE	Unable to trace			
FISH CAKES	Fishing boats	For the first fish product 3 days catches of 3 boats. For the second fish product 1days catch of 4 fishing boats	At most 30 minutes with the right numbers	9
FISH CAKES	Unable to trace			
SALMON FILLET	Fish farm	600 000 fish /parent fish	10 minutes	7
SALMON FILLET	Fish farm	fish farm	60 minutes	7

Table 5. Results of the simulated recall in the fruit and vegetable sector

PRODUCT	LAST TRACEABLE STEP	BATCH SIZE AT THIS STEP	ESTIMATED TIME TO TRACE BACK TO LAST STEP	NO OF LINKS IN SUPPLY CHAIN
APPLE	Farm	1 delivery kg	Less than120 minutes	4
BROCCOLI	Farm	1 delivery kg	Less than120 minutes	3
BANANA	Unable to trace			
PEPPER	Unable to trace			
APPLE	Farmers	140 farmers kg	Less than 48 hours	4
TOMATOES	Unable to trace			

Table 6. Results of the simulated recall in the grain sector

PRODUCT	LAST TRACEABLE STEP	BATCH SIZE AT THIS STEP	ESTIMATED TIME TO TRACE BACK TO LAST STEP	NO OF LINKS IN SUPPLY CHAIN
FLOUR	Flour Mill	Not defined	Not possible	3
BREAD	Cereal Silo	Not defined	Not possible	4
RICE PRODUCT			Not possible	5
BREAD		Did not want to participate in the study	Not possible	
FLOUR	Cereal Silo	Not defined	Not possible	4
CEREAL	Cereal Silo	Not defined		3

Table 7. Results of the simulated recall in the dairy sector

PRODUCT	LAST TRACEABLE STEP	BATCH SIZE AT THIS STEP	ESTIMATED TIME TO TRACE BACK TO LAST STEP	NO OF LINKS IN SUPPLY CHAIN
MILK	Farms	121 farms	About 60 minutes	4
YOGHURT	Farms	124 farms	About 120 minutes	3
CHEESE	Farms	275 farms	Less than 60 minutes	4
YOGHURT	Did not want to participate in project			
MILK	Farms	90 farms	Less than 24 hours	10
SOUR CREAM	Farms	circa 1162 farms	Less than 240 minutes	4

Table 8 Results of the simulated recall in the red meat sector

PRODUCT	LAST TRACEABLE STEP	BATCH SIZE AT THIS STEP	ESTIMATED TIME TO TRACE BACK TO LAST STEP	NO OF LINKS IN SUPPLY CHAIN
MINCED BEEF	Set of Animals	32 farms, 101animals	180 minutes +	8
BEEF STEAK	Set of Animals	60 farms 191 animals	180 minutes +	6
SALAMI		Unable to trace		
NECK CUTLETS	Unable to trace			
HAM	Set of Animals	3499 pigs	180 minutes +	
ENTRECOTE	Set of Animals	30 animals	180 minutes +	5

Figure text - figures are to be found in the attached JPEG files.

Figure 1. The method used during this study

Figure 2. The number of products which had an unknown origin and those with a known origin and fully known supply chain.

Figure 3. Comparison of data from the study with data from an American study (Levinson, 2009).

VITAE

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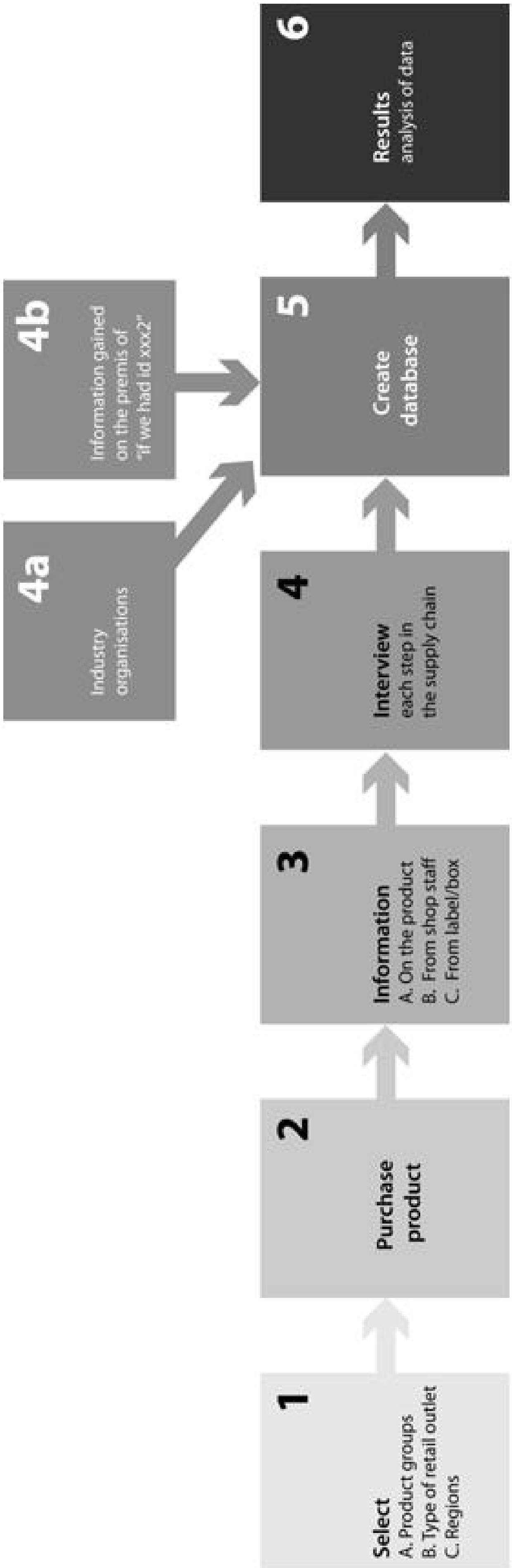
Figure 1.



1
Select
A. Product groups
B. Type of retail outlet
C. Regions
2
Purchase product
3
Information
A. On the product
B. From shop staff
C. From label/box
4
Interview
each step in
the supply chain
4a
Industry
organisations
4b
Information gained
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"if we had id xxx2"
5
Create
database
6
Results
analysis of data

Figure 2.

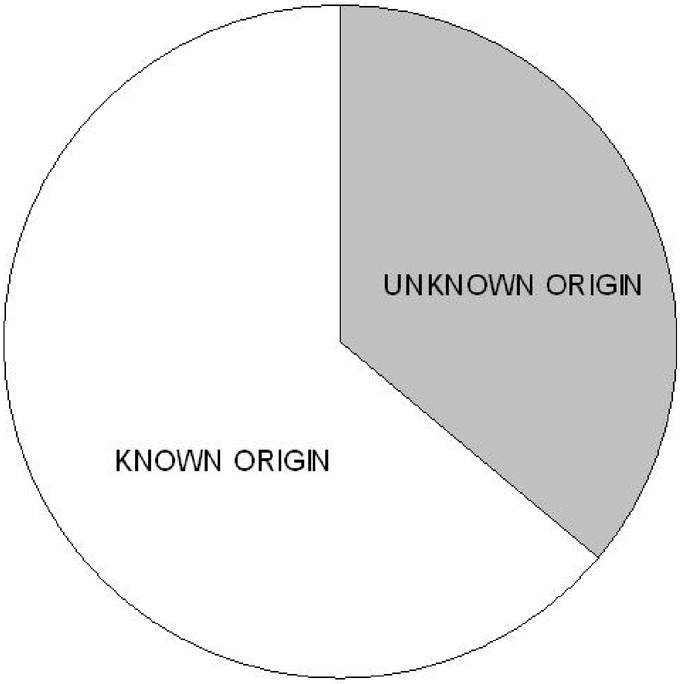
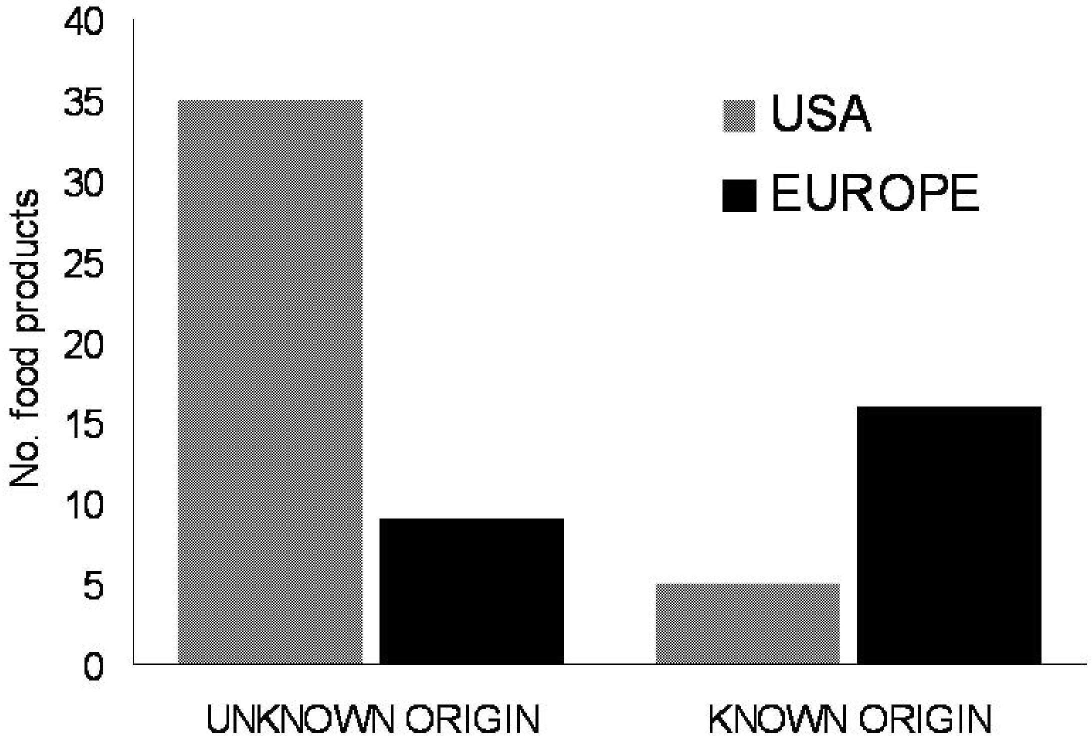


Figure 3.


40
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No. food products
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