UNDERSTANDING VULNERABILITY ASSESSMENT

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Section 1 Introduction

The Global Standard for Food Safety Issue 7 defines food fraud as the fraudulent and intentional substitution, dilution or addition to a product or raw material, or misrepresentation of the product or material, for the purpose of financial gain, by either increasing the apparent value of the product or by reducing the cost of its production. Examples include:

- replacing or substituting ingredients with cheaper alternatives (e.g. undeclared substitution of extra-virgin olive oil with lower grades of olive oil or oils of other botanical origin)
- undeclared dilution of genuine ingredients (e.g. the dilution of fruit juices and fruit preserves with undeclared cheaper fruits or sugar syrup)
- deliberate mis-labelling (e.g. of the animal species in a meat product)
- making false claims regarding provenance or origin (e.g. claiming organic status or making a false geographic or varietal claim)
- counterfeiting to copy a well-known brand (e.g. by falsification of records and/or packaging of inferior products, such as cheap wine).

In January 2013 the Food Safety Authority of Ireland reported that horse DNA had been found in products labelled as containing beef. This announcement resulted in an extensive incident throughout Europe and the recall of several beef products. However, food fraud and the deliberate adulteration of products and ingredients are not new issues and have been in existence for a long time. Food fraud is a global problem and due to the length and complexity of food supply chains

it often requires international solutions. Recently, there have been numerous well-publicised incidents including those listed in Table 1.

Table 1 Examples of food fraud incidents

YEAR	LOCATION	INCIDENT
1998	USA	Apple juice replaced with artificially flavoured sugar water
2008	China	Addition of melamine to milk powder (melamine cheated the quality tests that were in operation at the time, thus making the milk appear to be of higher value than it actually was)
2011	UK	Counterfeit bottles of branded wine
2013	EU	Beef substituted with horsemeat (horsemeat is cheaper than beef)
2013	UK	Premium manuka honey replaced with ordinary blended honey

The scale of food fraud is not precisely known, but estimates suggest that it costs the world economy $49 billion annually and is growing. In the US the University of Minnesota National Center for Food Protection and Defense (NCFPD) has estimated that about 10% of US food could be adulterated. This matches a similar estimate by the UK Food Standards Agency, which in 2006 also estimated that as much as 10% of consumers' weekly shopping may be counterfeit.

According to the Draft Report on the Food Crisis, Fraud in the Food Chain and the Control Thereof (2013/2091 (INI)) (European Parliament, 2013), the top 10 food products most at risk of adulteration or substitution are as follows:

- olive oil

- fish
- organic products
- milk
- grains
- honey and maple syrup
- coffee and tea
- spices (such as saffron and chilli powder)
- wine
- certain fruit juices

These incidents (and particularly those concerning horsemeat) have focused the attention of the food industry, regulatory authorities and consumers on the potential for food fraud and the need for effective systems to prevent it. Therefore, the Global Standard for Food Safety Issue 7 has introduced new requirements for a vulnerability assessment designed to ensure that all sites:

- have assessed their raw materials and supply chains for their vulnerability to food fraud activities
- have appropriate, risk-based controls in place to minimise the risk of purchasing fraudulent or adulterated raw materials.

This guideline is intended to help sites understand the requirements of the Global Standard for Food Safety Issue 7 relating to food fraud and explains how to conduct a vulnerability assessment to meet these requirements.

In addition, the BRC will develop training in food fraud awareness, details of which will be made available on its training website, **www.brctrainingacademy.com**

The Global Food Safety Initiative (GFSI) has confirmed that in future all GFSI standards will need to incorporate food fraud mitigation activities, such as the vulnerability assessment, within their requirements.

Section 2 Requirements of the standard

There are a number of requirements in the Global Standard for Food Safety Issue 7 in which the company must consider potential food fraud and adulteration of raw materials. These are set out in Table 2.

Table 2 Summary of the requirements of the Standard concerning food fraud and adulteration of raw materials

CLAUSE	SUMMARY OF THE REQUIREMENTS
1.1.6	The company must have a system for identifying new risks to the authenticity of raw materials.
3.5.1.1	The risk assessment of each raw material or group of raw materials must consider the potential for substitution or fraud.
5.4	The company must have systems in place to minimise the risk of purchasing fraudulent or adulterated food raw materials.
5.4.1	The company must have access to information on historical and developing threats relating to the risk of adulteration or substitution of raw materials.
5.4.2	The company must have a documented vulnerability assessment of all food raw materials.
5.4.3	Where a raw material is at risk of adulteration or substitution, appropriate assurance systems and/or testing must be in place to reduce the risk.

Section 3 Conducting a vulnerability assessment

3.1 Gathering information

The first stage of a vulnerability assessment is to source reliable information regarding the potential adulteration, substitution or mis-labelling of raw materials and the supply chain, on which the assessment can be based. This could include information as shown in Figure 1.

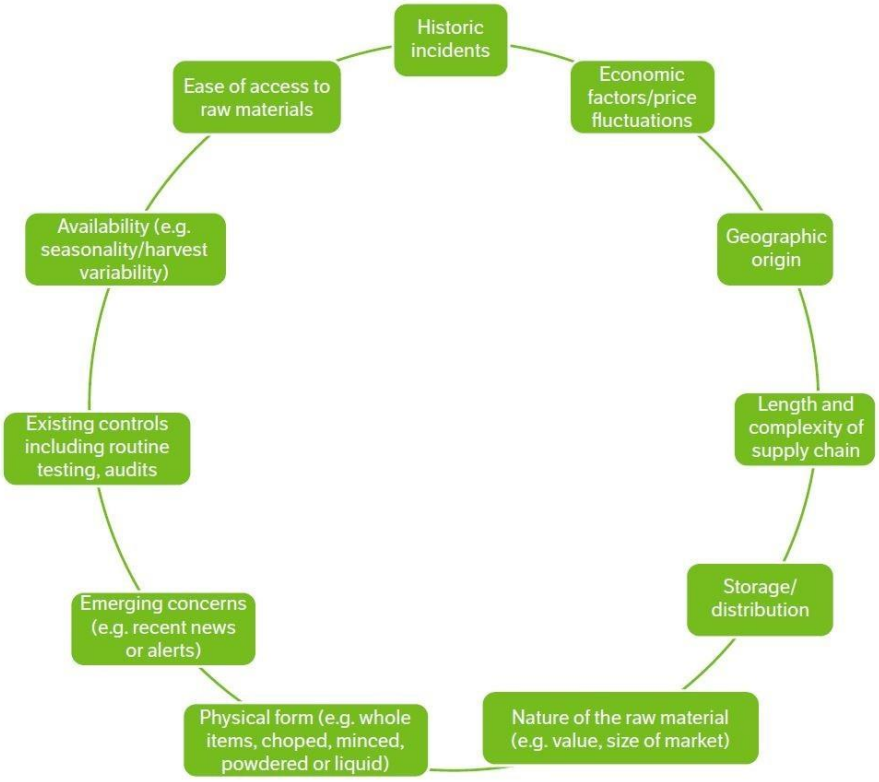

Figure 1 Gathering information on which to base the assessment

A number of organisations have websites which provide useful background information, summaries of historical cases and news of emerging concerns. These include:

- US Pharmacopeial Convention (USP): https://www.foodfraud.org/
- US National Center for Food Protection and Defense (NCFPD): https://www.ncfpd.umn.edu/
- US Michigan State University: http://foodfraud.msu.edu/
- US Food and Drug Administration (FDA): http://www.fda.gov/Food/FoodDefense
- UK Food Standards Agency (FSA): http://www.food.gov.uk/enforcement/foodfraud
- UK Serious Fraud Office: http://www.sfo.gov.uk/fraud
- UK Food and Drink Federation (FDF): http://www.fdf.org.uk/corporate_pubs/Food-Authenticity-guide-2014.pdf

It is important to note that information relating to the potential adulteration and food fraud of raw materials is constantly changing as new threats are identified and existing ones are managed. The company must therefore ensure that it remains up to date with relevant scientific and technical developments, emerging issues and known threats. Mechanisms to achieve this include:

- membership of a trade association that provides this service
- subscription to a service provider supplying updates on food fraud

•help from government officials or local enforcement officers (in countries where the authorities publish useful information on known incidents or emerging threats or are prepared to discuss these issues with the industry).

It should be noted that the most valuable resources are often those that proactively provide updates, as this avoids the potential for busy staff to forget to access the updated information.

During the audit the auditor will look for evidence of systematic checking and the process for ensuring that information is transferred into action as necessary (see section 3.2).

3.2 Vulnerability assessment

A vulnerability assessment is a search for potential weaknesses in the supply chain in order to prevent food fraud (i.e. to prevent the adulteration or substitution of raw materials before they arrive at the site). It is therefore a specialised form of risk assessment. It is important to note that the aim of the assessment is not to assess the potential for fraud at the site, but to examine the supply chain for potential concerns or weaknesses and therefore to identify those raw materials that are of particular risk of adulteration or substitution, so that appropriate controls can be put in place.

Vulnerability assessments will need to consider information relating to each ingredient. However, where a site purchases a number of similar raw materials it may be possible to consider these as a group rather than considering each raw material individually. When doing this care must be taken to ensure the risks are genuinely similar. For example, a company purchasing a range of fruit juices may be able to treat these as a group with a single vulnerability assessment, but before doing so,

it should consider whether the risks are actually the same – different countries, different supply chains or different crops may introduce new or different risks. The *Elliott Review into the Integrity and Assurance ofFood Supply Networks* (UK Government, July 2014) highlights that, 'Around 400 beverages with the taste of pomegranate were introduced to the market globally in 2012, an increase of 13% compared to 2011. In addition producers have quickly introduced pomegranate vinegar, liqueurs and syrups, and flavourings for confectionery. Pomegranate trees take 2–3 years after planting before they produce fruit.' In this case the sudden growth in demand may lead to increased prices and lower availability, potentially resulting in pomegranate being at a higher risk of adulteration than more common fruit juices.

The nature of the raw material may also influence the potential for food fraud. For example, if a slaughterhouse is purchasing cattle, horses and pigs for slaughter, it will be obvious if there is an issue with the live animals. However, if the slaughterhouse intends to make claims such as organic status, Aberdeen Angus or specified country of origin, then greater control of raw materials will be required to ensure that only those animals which meet the claim are purchased. Similarly, prepared ingredients such as beef mince or ground spices are likely to have a greater risk than the whole raw material.

There is no single, prescribed method of conducting a vulnerability assessment; any structured approach to identifying the risks can be used. The choice of methodology may therefore be a matter of personal preference or company policy. However, the vulnerability assessment is a specialised form of risk assessment and it is therefore logical to consider similar tools and methods. It is important to remember that the aim of the vulnerability assessment is to assess whether there is a genuine risk to raw materials irrespective of any potential consequences. In other words, it is trying to ascertain the likelihood of occurrence, how widespread any

occurrence would be and, most importantly, whether there are sufficient controls within the supply chain to prevent occurrence or whether additional controls are required.

Traditional risk assessment tools such as simple quadratic methods or quadrant graphs are useful in providing a structure and standardised approach. However, they commonly consider the consequence of an event if it were to occur (e.g. the severity). With vulnerability assessment, severity is not a particularly useful measure as (at the very least) the resultant product will always be illegal and therefore the consequences are always severe, regardless of whether there is an associated food safety issue or not. Furthermore, most adulteration cases do not have a food safety concern associated with them and the inclusion of severity may, if not handled correctly, lead to an underestimation of the importance of any identified risks.

Some sites have found tools such as TACCP, VACCP and CARVER + Shock useful in providing this structured approach.

Whichever approach is used, the general steps will include those set out in Figure 2.

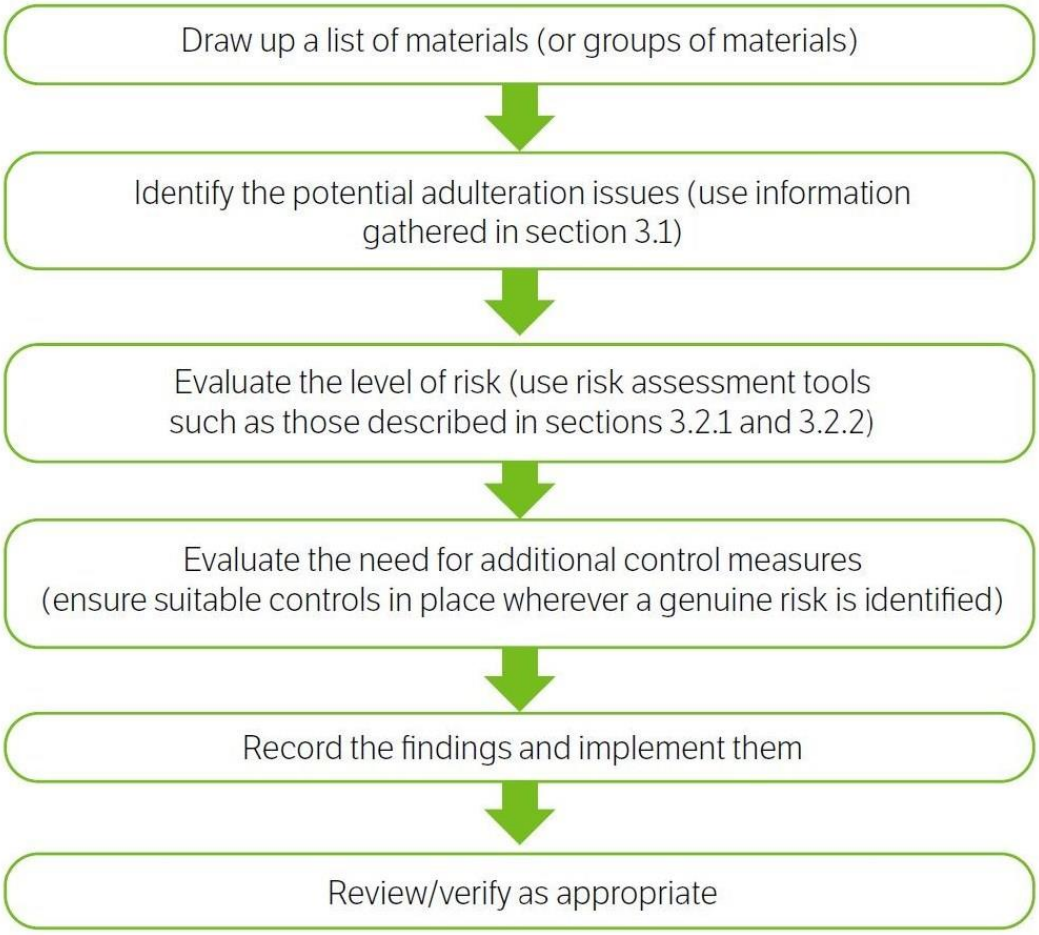

Figure 2 Steps in a vulnerability assessment

3.2.1 Simple quadratic model

Simple quadratic methods seek to assess the collated information regarding potential adulteration in tabular form, such as that shown in Figure 3.

		PARAMETER 1				
PARAMETER 2		Very unlikely	Unlikely	Fairly likely	Likely	Very likely/ certain
	Very unlikely					
	Unlikely/remote					
	Fairly likely					
	Likely					
	Very likely/ certain					

Figure 3 Example of a simple quadratic model

The available information is given a rating on one of the axes; either the horizontal axis (labelled Parameter 1) or the vertical axis (labelled Parameter 2). This allows the material's overall position on the table, and therefore its risk rating, to be determined. Each of the areas in the table is assigned a colour-coded rating: materials in the green areas are deemed low risk; those in the amber areas are medium risk; and those in the red areas are high risk. A high risk rating would mean that urgent action is required, and regular monitoring may be needed to manage the identified risk. A medium rating could mean that action is needed, with occasional monitoring to mitigate the risk. But the actual actions required need to be determined by the site (see section 3.3).

When completing food safety risk assessments it is common for the likelihood of occurrence to form the horizontal axis and severity to form the vertical axis. However, as discussed above, severity is not a useful parameter for the vulnerability assessment; it is much more useful to consider what could occur and whether any discrepancies would be noticed during the current goods receipt, quality assurance or testing activities. Therefore logical axes for the vulnerability assessment are:

- likelihood of occurrence – horizontal axis
- likelihood of detection – vertical axis.

In section 3.1 we considered the information that would need to be gathered for each ingredient (or group of ingredients) to allow a thorough vulnerability assessment to be completed. If we now categorise this information under either 'likelihood of occurrence' or 'likelihood of detection' the result would be a list similar to that shown in Table 3.

Table 3 Categorising information under likelihood of occurrence or detection

LIKELIHOOD OF OCCURRENCE	LIKELIHOOD OF DETECTION
Historic incidents	Geographic origin*
Emerging concerns (e.g. recent news or alerts)	Length and complexity of the supply chain*
Economic factors/price fluctuations	Physical form (e.g. whole items, chopped, minced, powdered or liquid)
Geographic origin/length and complexity of the supply chain*	Existing controls (e.g. supply chain audits)
Ease of access to raw materials (e.g. long or convoluted supply chains which allow multiple points of entry for fraudulent material)	Routine product testing (consider both the types of test used i.e. how likely they are to detect any adulterated materials, and the frequency at which the tests are completed)
Nature of the raw material (e.g. value of raw material/size of market)	Ease of access to raw materials (e.g. broken tamper-proof seals are clear evidence of an attempt to access)
Availability (e.g. seasonality/harvest variability)	Relevant audits (i.e. those which consider adulteration, traceability, mass balance testing etc.)
Availability of adulterants or substitutes	
Complexity and cost of committing the fraud	
*Some information may have an impact on both occurrence and detection and may therefore need to be considered in both parts of the assessment.	

The next step is to assess all the information collated and assign the likelihood of occurrence and likelihood of detection with ratings that can then be compared with chart shown in Figure 4. Therefore we end the assessment with an outcome that rates the ingredient as red (high risk), amber (medium risk) or green (low risk). These ratings are defined as follows:

Red High-profile raw material(s) with a genuine and current possibility of adulteration or substitution. If rigorous controls are not already in operation, then urgent additional work is needed to ensure their integrity and to confirm that only genuine materials are purchased.

Amber The raw materials may provide an attractive target for adulteration or substitution. The site will need to ensure that all identified risks are managed or monitored.

Green Materials are unlikely to be a target for adulteration or substitution based on current information. Reassessment should be completed if new information becomes available.

Worked examples using a simple quadratic model are shown in section 4.

		LIKELIHOOD OF OCCURRENCE				
LIKELIHOOD OF DETECTION		Very unlikely	Unlikely	Fairly likely	Likely	Very likely/ certain
	Very likely/ certain					
	Likely					
	Fairly likely					
	Unlikely/remote					
	Very unlikely					

Figure 4 Inputting the ratings for the likelihood of occurrence and detection into the simple quadratic model

3.2.2 Using priority risk numbers

Another example of a risk assessment tool that lends itself to a vulnerability assessment is priority risk numbers (PRN). The PRN tool categorises the information according to three criteria.

For example:

- likelihood of occurrence
- likelihood of detection
- profitability (i.e. how profitable the activity would be for a fraudster).

The information discussed in section 3.1 can then be assigned to each of these criteria, as shown in Table 4.

Table 4 Categorising information according to likelihood of occurrence, likelihood of detection and profitability

LIKELIHOOD OF OCCURRENCE	LIKELIHOOD OF DETECTION	PROFITABILITY
Historic incidents	Ease of access to raw materials (e.g. broken tamper-proof seals are clear evidence of an attempt to access)	Economic factors/price fluctuations*
Emerging concerns (e.g. recent news or alerts)	Physical form (e.g. whole items, chopped, minced, powdered or liquid)*	Ease of access to raw materials*
Economic factors/price fluctuations	Existing controls (e.g. supply chain audits)	Nature of the raw material (e.g. value of raw material/size of market)*
Geographic origin/length and complexity of the supply chain*	Length and complexity of the supply chain*	Availability/seasonality*
Ease of access to raw materials (e.g. long or convoluted supply chains which allow multiple points of entry for fraudulent material)	Routine product testing (consider both the types of test used i.e. how likely they are to detect any adulterated materials, and the frequency at which the tests are completed)	Complexity and cost of committing the fraud
Nature of the raw material (e.g. value of raw material/size of market)	Relevant audits (i.e. those which consider adulteration, traceability, mass balance testing etc.)	Availability of cheaper adulterants or substitutes
Physical form (e.g. whole items, chopped, minced, powdered or liquid)*		
Availability (e.g. seasonality/ harvest variability)		

*Some information may have an impact on more than one of the criteria and may therefore need to be considered in both parts of the assessment.

Each of the three criteria is then rated from 1 to 5, with 1 being very low or no risk and 5 being very high risk (note that for likelihood of detection, high risk equates to not detecting the fraud or substitution). Table 5 provides an example of risk ratings.

Table 5 Risk ratings

RATING	LIKELIHOOD OF OCCURRENCE (O)	LIKELIHOOD OF DETECTION (D)	PROFITABILITY (P)
1	Very unlikely or none	Certain	Very low
2	Unlikely or minor	High	Low
3	Moderate or significant	Fairly unlikely	Moderate or significant
4	High	Unlikely or remote	High
5	Very high	Very unlikely	Very high

The final stage is to multiply the three ratings to obtain a PRN score, as follows: Priority risk number (PRN) = Occurrence (O) × Detection (D) × Profitability (P)

The output of the calculation is therefore a PRN for each raw material (or group of raw materials) with a value of 1 (overall very low risk) to 125 (overall extremely high risk). Table 6 provides examples of PRNs for different raw materials.

Table 6 Priority risk numbers for different raw materials

RAW MATERIAL	LIKELIHOOD OF OCCURRENCE (O)	LIKELIHOOD OF DETECTION (D)	PROFITABILITY (P)	PRN (= O × D × P)
Group of raw materials A	2	1	1	2
Raw material B	2	3	3	18
Raw material C	4	1	3	12
Raw material D	5	4	3	60

From Table 6 it is apparent that:

- the raw materials in Group A are low risk and current good practices should be sufficient
- raw material D has an elevated risk as there are known cases of adulteration and the detection of any fraud is unlikely with the systems that are currently operating. Some additional controls and/or monitoring are required
- there is a level of risk associated with raw materials B and C, and some proportional action is likely to be required. However, for raw material C this risk is mitigated as any fraud has been assessed as easily detectable. This may be the case if, for example, positive release testing of each batch of raw material is in operation. In this situation no urgent action would be required as long as the likelihood of detection of any fraud remains certain.

3.2.3 Reviewing the vulnerability assessment

It is important that the vulnerability assessment remains up to date. It must be reviewed at least annually or when there is a significant change to the ingredient. As a guide, a review may be triggered by any of the following changes, although this is not an exhaustive list:

- new raw materials being considered for purchase
- a change in the country of origin or the supplier of raw materials
- a change in the financial situation of the raw material supplier or country of origin

- a change in the cost of raw materials, either upwards or downwards
- a change in the supply chain, logistics and delivery of materials
- a change in availability of the material (e.g. due to seasonal shortages)
- emergence of a new risk (e.g. publication of information relating to the adulteration of an ingredient
- developments in scientific information associated with ingredients, process or product
- information received as part of supplier approval or raw material risk assessment which highlights a new or evolving risk.

3.3 Prevention of fraud – introducing controls

Regardless of the model or approach used to complete the vulnerability assessment, a key part of the process is to establish appropriate controls or levels of action based on the outcome of the assessment. Where raw materials are identified as being of particular risk of adulteration or substitution, appropriate assurance controls need to be in place to ensure that only genuine materials are purchased. Depending on the perceived risk and the precise details of the supply chain, assurance controls may, for example, include:

- Certificates of analysis from raw material suppliers that include prescribed tests to demonstrate the authenticity of the material. The relevant tests will obviously depend on the nature of the product and the risk identified. Consideration should be given to the point where the testing is completed (for example, whether it is completed by the direct supplier or after the point of the identified risk).
- Raw material testing. Depending on the assessed risk, this could include positive release testing or periodic verification tests. Some industry sectors have also found it beneficial to organise group surveys (i.e. simultaneous tests of products from several different stakeholders) which can provide useful information on the current status of the market. The relevant tests obviously depend on the nature of the product and the risk identified, but could include:

- confirmation of species (e.g. ELISA or DNA testing)

- isotopic profiling to establish geographic or botanic origin

- testing in accordance with legislative definitions (e.g. EC Regulation 1348/2013 on the characteristics of olive oil and olive residue oil (*Official Journal of the European Union*, December 2013)

- compositional analysis

- Supply chain audits that include potential for fraud, adulteration, traceability and mass balance tests. These can be conducted either by the company or by a third party. Certification audits (such as audits against the BRC Standards) can cover all stages of the supply chain, including manufacturers, processors, traders, agents, brokers, storage facilities and distribution services.
- Mass balance exercises at critical points in the supply chain – the mass balance test is defined as a reconciliation of the amount of incoming raw material against the amount used in finished products. The objective of this mass balance is to confirm that sufficient quantities of genuine raw material have been purchased compared with the amount of product supplied.
- Use of tamper evidence or seals on incoming raw materials – as a minimum these must be in place throughout all the steps of the supply chain about which there is a concern.

•Enhanced supplier approval and risk assessment checks to ensure that the approval process is sufficiently rigorous and considers potential adulteration and substitution of ingredients.

•Ensuring traders and intermediaries (including processors, traders, cold stores, agents and brokers) are registered as food business operators with the appropriate regulatory authorities.

•Where there is a range of ingredient choices, it may be possible to choose alternative ingredients with lower risks.

•Ultimately, if the site cannot be confident about the integrity of the materials they receive, then it may be necessary to make changes to the supply chain. For example:

- move to a shorter supply chain (the longer and more complex the supply chain, the greater the number of points where a weakness could exist and allow entry of adulterated materials, and the more difficult the fraud is to detect)

- develop closer relationships with suppliers so that potential concerns are effectively communicated and proactively managed

- change the country of origin to one with a lower risk factor

- change the purchasing policy (e.g. avoid auctions or spot markets where traceability of ingredients is more difficult to establish).

While the specific controls and monitoring used to address an identified risk will be based on the nature of the raw material and the nature of the risk identified, it is worth noting that not all controls are equivalent. The most effective methods are often those which completely eliminate the risk from the supply chain. Where elimination is not possible, ingredient control is usually the next most effective step. Finally, less effective methods include product testing; this is not a control point, but monitors deliveries to identify adulteration and to prevent the use of adulterated materials, and it establishes whether other controls have worked. The different controls and their effectiveness are illustrated in Figure 5.

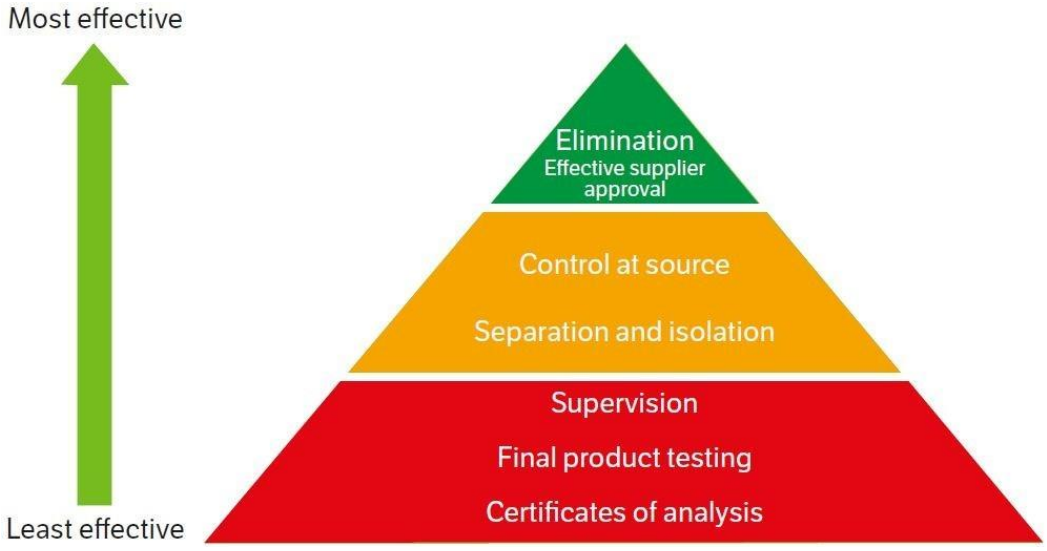

Figure 5 Control methods in order of effectiveness

Section 4 Worked examples

Sections 4.1, 4.2 and 4.3 show how the tools discussed in section 3 might be used on three real products: manuka honey (4.1), sugar (4.2) and dried fruit (4.3).

4.1 Purchase of manuka honey

A site purchases manuka honey as a raw material. The first step of the vulnerability assessment is to gather relevant information and evidence on which to base the assessment. This information could be summarised as shown in Table 7.

LIKELIHOOD OF OCCURRENCE	SUMMARY OF EVIDENCE COLLECTED BY SITE
Historic incidents Emerging concerns (e.g. recent news or alerts)	Multiple reports indicating both historic and current concerns. For example: 'Research by the main honey producers' organisation in New Zealand, from where almost all the world's manuka honey comes, revealed that 1,700 tons of manuka are produced there each year, compared with the estimated 1,800 tons of New Zealand "manuka" honey sold in the UK alone. As much as 10,000 tons are sold worldwide, suggesting widespread fraud.' (*Elliott Review into the Integrity and Assurance of Food Supply Networks*)
Economic factors/price fluctuations	Manuka honey is a premium product, with limited availability resulting in high prices – demand exceeds supply.
Geographic origin/length and complexity of the supply chain	Manuka honey can be purchased only from a limited geographic area.
Ease of access to raw materials (e.g. long or convoluted supply chains which allow multiple points of entry for fraudulent material)	No specific issues relating to access to raw materials.
Nature of the raw material (e.g. value/size of market)	Refer to economic factors/price fluctuations above.
Availability (e.g. seasonality/harvest variability)	Manuka honey is a seasonal product on the basis that the manuka plant flowers in spring and summer, not throughout the year.
Availability of adulterants Complexity and cost of committing the fraud	Other varieties of honey, sugar syrup and water are readily available and significantly cheaper than manuka honey.
Site conclusion for likelihood of occurrence Very high risk as occurrence in some supply chains is very likely.	
LIKELIHOOD OF DETECTION	**SUMMARY OF EVIDENCE COLLECTED BY SITE**
Geographic origin Length and complexity of the supply chain	Complexity of supply chain dependent on sourcing policy – buying direct from New Zealand producers is preferable to purchasing from non-producing traders.
Physical form (e.g. whole items, chopped, minced, powdered or liquid)	Physical form means that dilution or substitution is relatively straightforward.
Existing controls (e.g. supply chain audits)	Basic supplier approval.
Routine product testing (consider both the types of test used i.e. how likely they are to detect any adulterated materials, and the frequency at which the tests are completed)	Few internationally recognised tests available. Therefore some results can be costly, time-consuming, difficult to interpret and subjective.
Ease of access to raw materials (e.g. broken tamper-proof seals are clear evidence of an attempt to access)	Refer to geographic origin above – no additional controls in operation.
Relevant audits (i.e. those which consider adulteration, traceability, mass balance testing etc.)	None.
Site conclusion for likelihood of detection High risk as testing is limited and complex. It is therefore very unlikely that all occurrences of adulteration or substitution will be detected.	

Using the simple quadratic model discussed in section 3.2.1, it is straightforward for the site to conclude that manuka honey is a red-rated (i.e. high-risk) ingredient, as shown in Figure 6.

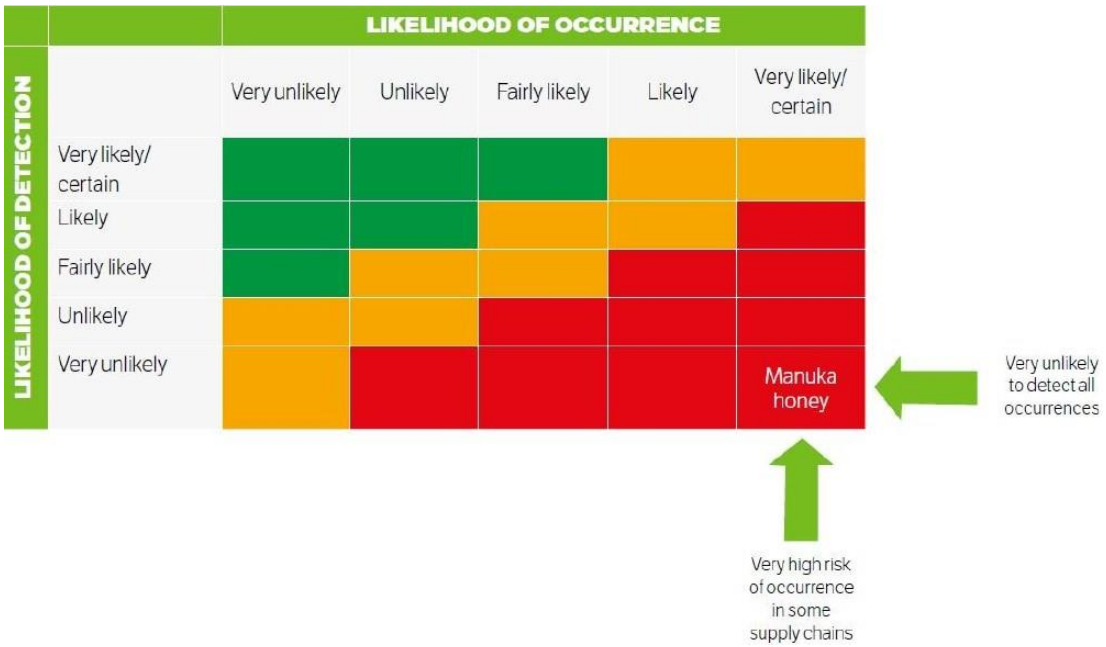

Figure 6 Risk rating for manuka honey

The final step in the process is to ensure that where a genuine risk has been identified, suitable controls are in place to ensure that the site purchases only authentic material. Suitable controls for manuka honey might include:

•Assess whether the site actually needs to purchase manuka honey or whether an alternative honey would be satisfactory.

•If genuine manuka honey is required:

- review the purchase process to ensure that the ingredient is purchased as close to the source as possible

- ensure that supplier approval is rigorous and includes assessment of controls to prevent adulteration or substitution

- ensure that supplier approval includes appropriate certification

- receive a certificate of analysis with every batch of honey received

- carry out periodic testing of the received material.

4.2 Purchase of sugar

A site purchases white sugar manufactured from sugar beet for use as a raw material. Using the same format as in section 4.1, Table 8 summarises the collated information.

Table 8 Vulnerability assessment for sugar

LIKELIHOOD OF OCCURRENCE	SUMMARY OF EVIDENCE COLLECTED BY SITE
Historic incidents	A small number of historical references, predominantly referring to the 19th century.
Emerging concerns (e.g. recent news or alerts)	Two recent items: • wrong declaration of geographic origin (refer to economic factors/price fluctuations below) • reports indicate that higher-priced sugars (e.g. palm or beet) have been mixed with cheaper, imported cane sugar.
Economic factors/price fluctuations Nature of the raw material (e.g. value/size of market)	A number of countries, such as those in the EU, have complex tariff/rebate systems designed to ensure local producers remain competitive on the world market. Abuses of these systems (predominantly relating to geographic origin) have been extensively reported and investigated.
Geographic origin/length and complexity of the supply chain	Many countries throughout the world produce sugar. There are no country-of-origin claims on the final product, and no sudden spikes in the cost. The supply chain is deliberately kept short. Sugar is purchased only from refineries in the same country as the site to simplify supplier management and to minimise the risk of fraud associated with longer supply chains.
Ease of access to raw materials (e.g. long or convoluted supply chains which allow multiple points of entry for fraudulent material)	Refer to geographic origin above – no additional points relating to ease of access.
Availability (e.g. seasonality/harvest variability)	Sugar beet harvest is seasonal; however, a sufficient quantity is available from local sources.
Availability of adulterants Complexity and cost of committing the fraud	The difference in price between imported cane and 'locally' grown beet can be significant. However, supplier approval includes assessment of potential for adulteration – sugar refineries used for supply do not have cheaper ingredients on site.
Site conclusion for likelihood of occurrence Occurrence is unlikely in the current supply chain. However, it is fairly likely in other supply chains. The risk rating would therefore be greater if the sugar had to be imported (i.e. if the supply chain were longer or there were additional handlers/transportation requirements).	

Table 8 Vulnerability assessment for sugar continued

LIKELIHOOD OF DETECTION	SUMMARY OF EVIDENCE COLLECTED BY SITE
Geographic origin	Countries of origin are geographically diverse. However, the site limits its sourcing to avoid managing multiple suppliers and because it has a company policy of sourcing locally wherever practical. Therefore no sugar is imported for use at the site. This limited supply base decreases likelihood of occurrence and increases likelihood of detection.
Length and complexity of the supply chain	Short supply chain – sugar is purchased only from the country where the manufacturing site is based and no sugar is imported. Supplier is dedicated to the production of sugar beet and does not have sugar cane on site.
Physical form (e.g. whole items, chopped, minced, powdered or liquid)	Fine white powder – visual inspection will not identify adulteration.
Existing controls (e.g. supply chain audits)	Supplier approval includes policies relating to imported raw materials and use of sugar cane.
Routine product testing (consider both the types of test used i.e. how likely they are to detect any adulterated materials, and the frequency at which the tests are completed)	No testing completed.
Ease of access to raw materials (e.g. broken tamper-proof seals are clear evidence of an attempt to access)	Short supply chain – direct from refinery to site. Adulteration could occur only at the supplier's site.
Relevant audits (i.e. those which consider adulteration, traceability, mass balance testing etc.)	Supplier has certification to the Global Standard for Food Safety Issue 7. This does not specifically assess fraud but includes tests of traceability and mass balance.
Site conclusion for likelihood of detection Detection is difficult (i.e. unlikely). However, this is mitigated by purchasing only from local companies (i.e. no imported sugar is used) and ensuring that rigorous supplier approval processes cover all the relevant issues.	

Using the simple quadratic model discussed in section 3.2.1, it is straightforward for the site to conclude that its refined white sugar is an amber-rated (i.e. medium-risk) ingredient, as shown in Figure 7.

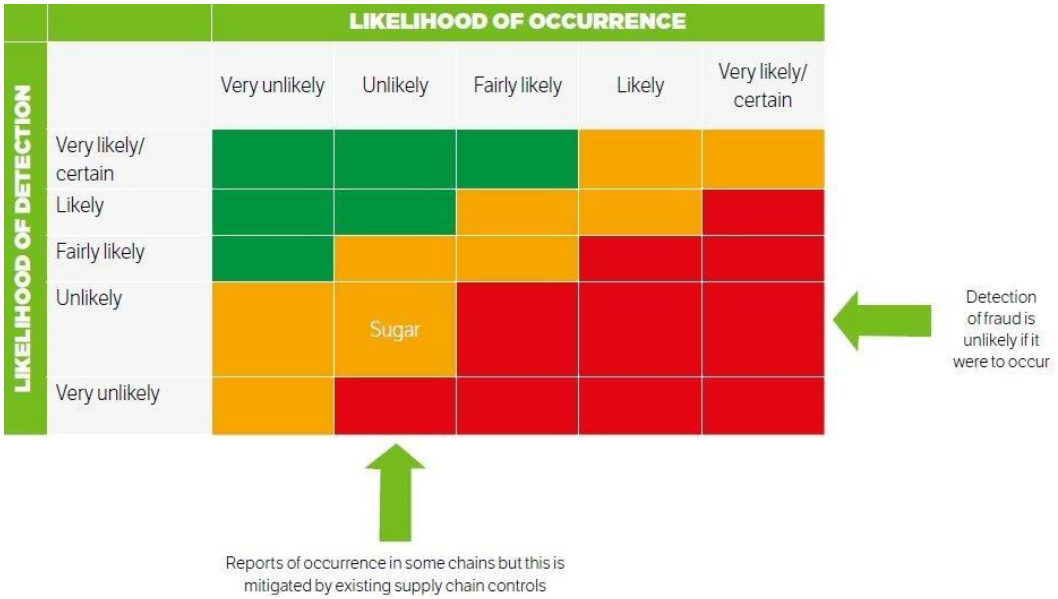

Figure 7 Risk rating for sugar

The amber (medium) risk rating indicates that the site needs to remain vigilant. The current risk rating depends on a number of supply chain controls that must be maintained. These controls focus on:

- limiting the number of suppliers
- purchasing sugar direct from refineries (i.e. from source) – and all in the same country as the site
- ensuring that all refineries are certificated/audited and thatthe audits include traceability/mass balance

•only approving suppliers that have a clear, established policy on imported ingredients/products and sugar cane (to remove the potential for an incorrect product to be received).

4.3 Purchase of dried fruit

A bakery purchases three types of dried fruit: raisins, sultanas and currants. Because of the similarities between the products and their supply chains, the site has elected to treat them as a single group of raw materials for the purposes of the vulnerability assessment. Using the same format as in sections 4.1 and 4.2, the collated information is summarised in Table 9.

Table 9 Vulnerability assessment for dried fruit.

LIKELIHOOD OF OCCURRENCE	SUMMARY OF EVIDENCE COLLECTED BY SITE
Historic incidents	None recorded.
Emerging concerns (e.g. recent news or alerts)	
Economic factors/price fluctuations	Dried fruit has a long shelf life and is produced in several countries, ensuring availability and no sudden spikes in the cost.
Nature of the raw material (e.g. value/size of market)	No specific issues relating to access to raw materials.
Geographic origin/length and complexity of the supply chain	Produced in several countries. There are no country-of-origin claims on the final product.
Ease of access to raw materials (e.g. long or convoluted supply chains which allow multiple points of entry for fraudulent material)	No specific issues relating to access to raw materials.
Availability (e.g. seasonality/harvest variability)	As for economic factors/price fluctuations above. Although crops are seasonal, they have a long shelf life and are produced in a number of countries. Therefore there are no issues with availability.
Availability of adulterants	No obvious adulterants – refer to likelihood of detection below as the substitution of other dried fruits would be detected during quality tests.
Complexity and cost of committing the fraud	
Site conclusion for likelihood of occurrence Adulteration or substitution is unlikely. Review would be required if, for example, claims were added to pack or the number of sourcing countries were expanded.	
LIKELIHOOD OF DETECTION	**SUMMARY OF EVIDENCE COLLECTED BY SITE**
Geographic origin	Countries of origin are geographically diverse, including Greece, Turkey, South Africa and Australia. However, the site limits its sourcing to avoid managing multiple suppliers in different countries.
Length and complexity of the supply chain	
Physical form (e.g. whole items, chopped, minced, powdered or liquid)	Whole items, visually distinct. All raw material has to be closely examined before use because of the potential for clumping (affecting quality) and foreign objects (e.g. naturally occurring twigs and stones).
Existing controls (e.g. supply chain audits)	Basic supplier approval.
Routine product testing (consider both the types of test used i.e. how likely they are to detect any adulterated materials, and the frequency at which the tests are completed)	Ad hoc product testing concentrates on potential contamination rather than authenticity.
Ease of access to raw materials (e.g. broken tamper-proof seals are clear evidence of an attempt to access)	No specific issues relating to access to raw materials.
Relevant audits (i.e. those which consider adulteration, traceability, mass balance testing etc.)	Sites are certificated to the Global Standard for Food Safety Issue 7.
Site conclusion for likelihood of detection All raw materials have to be checked as part of quality control and for the prevention of food safety risks. Any adulteration or substitution is therefore very likely to be detected.	

Using the simple quadratic model discussed in section 3.2.1 it is straightforward for the site to conclude that its dried fruit is green-rated (i.e. low risk), as shown in Figure 8.

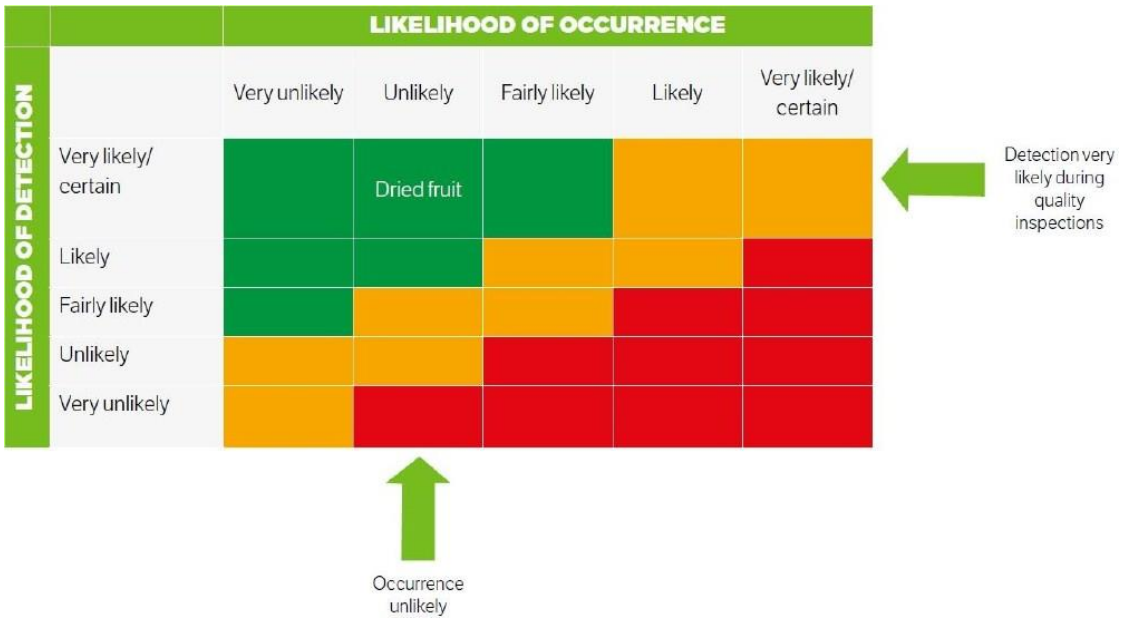

Figure 8 Risk rating for dried fruit

Current good practices should therefore be sufficient. Additional new controls are not required, but this would need to be reviewed if new information became available or if a wider range of dried fruits were to be purchased.

Glossary

ADULTERATION	The addition of an undeclared material into a food item for economic gain.
AUTHENTICITY	Food authenticity is ensuring that food or raw materials purchased and offered for sale are of the nature, substance and quality expected.
CARVER + SHOCK	A set of vulnerability assessment tools developed in the USA. The name CARVER + Shock stands for: Criticality – a measure of the impacts Accessibility – ability to access the target area or product Recuperability – how quickly the site could recover Vulnerability – ease of accomplishing the attempted fraud or attack Effect – amount of direct loss, i.e. loss of production Recognisability – ease of identifying the product Shock – health, economic and psychological impacts.
FOOD FRAUD	Fraudulent and intentional substitution, dilution or addition to a product or raw material, or misrepresentation of the product or material, for the purpose of financial gain, by increasing the apparent value of the product or by reducing the cost of its production.
TACCP	Threat Assessment and Critical Control Point (TACCP) is a system designed to give a structured approach to the assessment of the security of food and drink in relation to malicious contamination and food fraud.
VACCP	Vulnerability Analysis and Critical Control Points (VACCP) is a system designed to give a structured approach to the assessment of the security of food and drink in relation to financially motivated food fraud.
VULNERABILITY ASSESSMENT	A documented risk assessment designed to identify potential sources of food fraud within the supply chain and to prioritise suitable control measures to minimise the chances of receiving fraudulent or adulterated raw materials.