The Director General

Maisons-Alfort, 9 May 2014

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

relating to consumer information on prevention of biological hazards

ANSES undertakes independent and pluralistic scientific expert assessments.
ANSES primarily ensures environmental, occupational and food safety as well as assessing the potential health risks they may entail.
It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its opinions are made public. This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 9 May 2014 shall prevail.

On 2 May 2012, ANSES received a formal request from the Directorate General for Food (DGAL) for an Opinion on consumption recommendation statements on food labelling to prevent biological hazards.

1. BACKGROUND AND PURPOSE OF THE REQUEST

According to European regulations, the strategy for managing food risks is based primarily on prevention of contamination at the primary production stage, and control of hazards at each stage of the food chain. However, specific information intended for the most vulnerable consumers could help reduce the risk of certain foodborne diseases (for example, haemolytic uraemic syndrome (HUS), listeriosis, infant botulism, hepatitis E).

The means by which consumers are informed also need to be assessed in terms of benefits to public health and impact on the sector concerned. The following questions were asked in the DGAL's request:

- Which methodology should be applied to define the measures aimed at each of the parties involved (food business operators, health professionals, consumers), in a way that prioritises them and is proportional to the risk, and how should these measures be combined to achieve optimal efficiency of the health control scheme in terms of benefits to public health, while remaining proportionate to any constraints for the sector concerned?

- Can the Agency draw up a list of hazard-food combinations of priority to public health for which mandatory specific labelling (reference to the hazard or advice and precautions on use for vulnerable populations) would be likely to significantly improve consumer protection, after having examined the other options regarding information targeted at the populations concerned?

In agreement with the supervisory authorities, the questions were reformulated and it was agreed that the Working Group should examine the following points:

1. Identification of hazard-food combinations (or hazard-food-vulnerable population combinations) for which better consumer information may have an impact on risk reduction (compared to upstream control measures)
   1.1. Prioritisation of the hazard-food combinations according to the impact of preventive measures that can be applied by the consumer
   1.2. Quantitative assessment of the health impact of the consumer applying preventive measures on representative hazard-food combinations
2. Identification of conditions and criteria of effectiveness for the various information measures that could be applied for the combinations identified
   2.1. Inventory of conceivable information measures on the food risks
   2.2. Conditions and criteria of effectiveness for the measures
3. Identification of conditions and criteria of effectiveness for the various information measures: case study on a hazard-food combination.

2. ORGANISATION OF THE EXPERT APPRAISAL

The expert appraisal was carried out in accordance with French standard NF X 50-110 “Quality in Expert Appraisals – General requirements of Competence for Expert Appraisals (May 2003)”.

It falls within the sphere of competence of the Expert Committee (CES) on “Assessment of the biological risks in foods” (BIORISK). It was entrusted by ANSES to the Working Group (WG) on "Consumer information on biological risks related to foods". The methodological and scientific aspects of the work were presented to the CES BIORISK between 5 September 2013 and 18 March 2014. The Working Group on "Human and Social Sciences" (SHS) was consulted on the sociological and socioeconomic aspects. The work was adopted by the CES BIORISK at its meeting on 18 March 2014.

ANSES analyses the links of interest declared by the experts prior to their appointment and throughout the work, in order to avoid potential conflicts of interest with regard to the matters dealt with as part of the expert appraisal. The experts’ declarations of interests are made public via the ANSES website (www.anses.fr).

The expert appraisal work described in this Opinion focused on:

- Prioritisation of the hazard-food combinations according to the impact of preventive measures that can be applied by the consumer (1.1);
- Inventory of conceivable information measures on the microbiological food risks (2.1).

The other questions (1.2, 2.2 and 3) will be addressed in a second report planned for 2015.

3. ANALYSIS AND CONCLUSIONS OF THE CES

▶ Determination of hazard-food combinations for which consumer information may have an impact on the risk

Identifying and prioritising these hazard-food combinations drew on:

- French and international epidemiological data;
- Previous work by ANSES on the hazards considered, in particular:
    - knowledge summarised in the data sheets on foodborne biological hazards,
    - the Opinion on prevention of microbiological food risks by consumers in their homes (ANSES, 2013);
- data from the scientific literature.

The following approach was adopted to identify and rank hazard-food combinations for which better consumer information may have an impact on risk reduction:

- Identification of the main foodborne biological hazards and ranking of these hazards according to their public health impact. This public health impact takes into account the incidence of diseases they are responsible for, and their severity.
- Identification of the main foods or food groups behind the transmission of the previously identified biological agents.
- Qualitative assessment of the impact of preventive and control measures that can be applied by consumers on the risks associated with the hazard-food combinations.

The biological hazards included in the study are bacteria (as well as their toxins or metabolites), viruses, parasites and toxins (marine biotoxins) responsible for the most frequent and/or most severe foodborne diseases. The main food sources of these hazards were identified on the basis of knowledge documented in the data sheets on foodborne biological hazards. These are the foods most frequently contaminated or responsible for outbreaks.

The ranking process was based on three criteria:

- Incidence of foodborne diseases
- Severity of the disease associated with the hazard
- Effectiveness of the preventive measures that can be applied by the consumer on the hazard-food combination in question, assuming perfect application by consumers.

For each of these criteria, scores were awarded based on the data collected and expert opinion.

- ***Annual Incidence of foodborne diseases***

The annual incidence (abbreviated to "incidence" in the remainder of the text) of foodborne diseases was assessed taking into account surveillance data in France over the period 2009-2011. These data alone cannot be used to estimate the absolute weight of these different diseases. Studies estimating morbidity and mortality from foodborne diseases conducted in France for the 1990s (Vaillant *et al.*, 2005), in the Netherlands in 2009 (Havelaar *et al.*, 2012), in the United States over the period 2000-2008 (Scallan et al., 2011) and in Canada over the period 2000-2010 (Thomas *et al.*, 2013) were also used as sources of information in order to confirm certain trends.

A score of between 0 and 5 was awarded depending on the order of magnitude of this incidence according to the following scale:

- a score of 0 for an incidence of less than 1 case per 10 million inhabitants,
- a score of 1 for an incidence of between 0.1 and 1 case per million inhabitants,
- a score of 2 for an incidence of between 0.1 and 1 case per 100,000 inhabitants,
- a score of 3 for an incidence of between 1 and 10 cases per 100,000 inhabitants,
- a score of 4 for an incidence of between 10 and 100 cases per 100,000 inhabitants,

- a score of 5 for an incidence of more than 100 cases per 100,000 inhabitants.

- ***Severity of the disease associated with the hazard***

The metric used to assess the severity of diseases is the DALY (Disability Adjusted Life Years). The DALY corresponds to the sum of potential life years lost due to premature mortality and/or productive life years lost due to disability. The average DALY for a disease depends on the mortality associated with the disease and the severity of this disease, which depends on profiles of patients in terms of age, sex and the symptoms/syndromes observed.

In the absence of recent French data on the burden of foodborne diseases, the Working Group drew on estimates of DALY provided by Havelaar *et al.* (2012) concerning the Dutch population in 2009, and on expert opinion.

A severity score of between 1 and 4 was awarded according to the following scale:

- a score of 1 for an estimated DALY of less than 10 years for 1000 cases
- a score of 2 for an estimated DALY of between 10 and 100 years for 1000 cases
- a score of 3 for an estimated DALY of between 100 and 1000 years for 1000 cases
- a score of 4 for an estimated DALY of more than 1000 years for 1000 cases

- ***Effectiveness of the preventive measures that can be applied by the consumer on the hazard-food combination in question***

Seven preventive and control measures that can be applied by consumers, mainly selected on the basis of the ANSES Opinion on prevention of microbiological food risks by consumers in their homes (ANSES, 2013), were taken into account:

- Preventing cross-contamination
- Washing and decontaminating fruits and vegetables
- Rapid cooling
- Deep freezing
- Cooking
- Respecting the cold chain and the use-by date
- Avoiding consumption of the food by population groups vulnerable to the hazard (e.g. infants, young children, pregnant women, immunocompromised individuals or those suffering from chronic diseases)

The impact of the various measures on the risk was assessed qualitatively, assuming ideal application by the consumer, according to the following scale:

- a score of 0 for zero or almost zero effectiveness
- a score of 1 for partial effectiveness
- a score of 2 for total or almost total effectiveness

- ***Ranking results***

➢ *Ranking of hazards according to their public health impact*

The public health impact of each hazard on the entire French population is proportional to the product of its incidence (number of cases for 100,000 inhabitants) and its severity (disability years for 1000 cases). This equates to adding the incidence and severity scores reflecting these two parameters on a logarithmic scale.

The classification obtained is presented in the table below (Table 1). This ranking helps to identify hazards presenting a significant risk to the population, for which questions could be raised about the adequacy of consumer information measures. The agents with the greatest public health impact are Shiga toxin-producing *E. coli* (STEC), *L. monocytogenes, T. gondii, Campylobacter*, *Salmonella* and acute gastroenteritis viruses.

Table 1: Classification of hazards according to their health impact

Hazards	Incidence score	Severity score	Public health impact result (Incidence + severity score)
Escherchia coli STEC (SHU)	2	4	6
Listeria monocytogenes	2	4	6
Toxoplasma gondii (congenital form)	2	4	6
Campylobacter spp.	4	2	6
Salmonella (non- typhoidal)	4	2	6
Acute gastroenteritis virus (mainly norovirus)	5	1	6
Echinococcus multilocularis	1	4	5
Hepatitis A virus	2	3	5
Hepatitis E virus (autochthonous infections)	2	3	5
Yersinia enterocolitica	3	2	5
Bacillus cereus	4	1	5
Clostridium perfringens	4	1	5
Staphylococcus aureus	4	1	5
Clostridium botulinum (infant botulism)	0	4	4
Cronobacter spp.	0	4	4
Clostridium botulinum (intoxication)	1	3	4
Marine biotoxins (ASP, PSP)	1	3	4
Ciguatoxin	1	3	4
Taenia saginata	3	1	4
Brucella spp.	1	2	3
Shigella	1	2	3
Trichinella	1	2	3
Histamine	2	1	3
Cryptosporidium	2	1	3
Giardia spp.	2	1	3
Marine biotoxins- DSP	2	1	3
Fasciola hepatica	0	2	2
Vibrio parahaemolyticus	1	1	2
Anisakis spp.	1	1	2
Cyclospora cayentanensis	0	1	1

➢ *Ranking of the hazard-food combinations according to the impact of measures applied by the consumer*

For each hazard, the main food sources were identified and related to the preventive measures that can be applied to reduce the risk associated with each of these combinations. The impact of the preventive measures was then estimated. Table 2 below shows the results for the main hazard-food combinations (health impact score above 4 for the hazard), sorting them in order of the overall impact of the preventive measures.

This final ranking of the hazard-food combinations therefore takes into account their current health importance as well as the potential risk reduction attributable to the preventive measures when applied perfectly by the consumers.

Table 2: Ranking of the main* hazard-food combinations according to the impact of preventive measures that can be applied by the consumer

Hazard	Food	Preventive measures associated with the combination	Overall impact of the preventive measures (including avoiding consumption by vulnerable populations**) on the risk (0: zero, 1: partial, 2: total)
STEC	Cooked minced beef	Cooking	2
STEC	Raw milk	Cooking, avoiding consumption	2
T. gondii	Meat	Cooking, deep freezing	2
Campylobacter	Poultry meat	Cooking, preventing cross-contamination	2
Salmonella	Eggs	Cooking	2
Salmonella	Meat	Cooking, preventing cross-contamination	2
Salmonella	Infant milk reconstituted from powdered infant formula	Cooking	2
E. multilocularis	Red fruits and berries	Cooking	2
HEV	Raw pork liver products, wild boar offal	Cooking, avoiding consumption	2
Y. enterocolitica	Pork meat	Cooking	2
B. cereus	Refrigerated cooked meals	Appropriate storage	2
B. cereus	home-made cooked meals	Appropriate storage, cooling	2
C. perfringens	home-made cooked meals	Appropriate storage, cooling	2
S. aureus	Delicatessen products	Appropriate storage, cooling	2
Cronobacter	Infant milk reconstituted from powdered infant formula	Cooking, cooling, storage	2
C. botulinum (intoxication)	Home-made preserves	Preparation, cooking	2
C. botulinum (intoxication)	Home-made delicatessen meats	Preparation	2
C. botulinum (intoxication)	Refrigerated vacuum-packed cooked meals	Appropriate storage, cooking	2
T. saginata	Beef	Cooking	2
STEC	Raw minced beef	Preventing cross-contamination, avoiding consumption	2
STEC	Soft raw-milk cheeses	Preventing cross-contamination, avoiding consumption	2
T. gondii	Raw fruit and vegetables	Washing, avoiding	2

Hazard	Food	Preventive measures associated with the combination	Overall impact of the preventive measures (including avoiding consumption by vulnerable populations**) on the risk (0: zero, 1: partial, 2: total)
		consumption	
C. botulinum (infant botulism)	Honey	Avoiding consumption**	2
STEC	Raw fruit and vegetables	Preventing cross-contamination, washing	1
L. monocytogenes	Ready-to-eat foods able to support the growth of *L. monocytogenes*	Appropriate storage, avoiding consumption	1
Salmonella	Raw-egg-based products	Preventing cross-contamination, storage	1
Salmonella	Raw-milk cheese	Preventing cross-contamination, appropriate storage	1
Salmonella	Raw fruit and vegetables	Preventing cross-contamination, washing	1
Acute gastroenteritis virus	Cooked shellfish	Cooking	1
Acute gastroenteritis virus	Food handled at home prior to consumption	Preventing cross-contamination	1
HAV	Cooked shellfish	Cooking	1
HAV	Food handled at home prior to consumption	Preventing cross-contamination	1
Acute gastroenteritis virus	Raw shellfish	–	0
Acute gastroenteritis virus	Fruit and vegetables consumed raw including deep frozen	–	0
HAV	Raw shellfish	–	0
HAV	Fruit and vegetables consumed raw including deep frozen	–	0
S. aureus	Soft raw-milk cheeses	–	0
Marine biotoxins (PSP, ASP)	Shellfish	–	0
Ciguatoxin	Fish	–	0

* Top 19 hazards in the public health impact ranking (score greater than or equal to 4)
** The impact of avoiding consumption was only assessed when a vulnerable population was identified for the hazard in question.

As a complement to the approach based on the assessment of preventive measures taken individually on the risk related to a hazard-food combination, an assessment was conducted of the potential impact of the preventive measures on reducing the overall risk. The health impact scores for the hazard-food combinations were added together to assess the overall health burden and their relative importance was calculated and expressed as a percentage. This estimation reveals that:

- Cooking and cooling of meat and cooked meals are measures that have almost total effectiveness, and if the consumer applies them properly this could remove over 30% of the overall microbiological risk.
- Appropriate storage of delicatessen products and cooked meals could eliminate around 15% of the overall microbiological risk.
- Respecting preparation and storage rules for infant milk could eliminate 3% of the overall health burden, while avoiding consumption of specific products (honey, raw minced beef and

raw-milk dairy products) by infants or young children could eliminate 8% of the overall microbiological risk.

- The risks associated with raw fruits and vegetables account for around 17% of the overall health impact and the preventive measures that can be applied by consumers (washing and deep freezing) may only allow a partial reduction of this risk.
- In the case of shellfish, which account for about 10% of the overall risk, only action by food industry operators is possible, because the preventive measures that can be applied by consumers are unlikely to significantly reduce this risk.

▶ Impact on consumption behaviour of information aiming to reduce microbiological risks

Two approaches were followed to collect information and data on the impact of information on microbiological risks on consumer behaviour:

1. A literature search on the theme "impact on consumption behaviour of information aiming to reducing microbiological risks via food": The selected articles were examined by the WG experts according to a predefined analysis grid.
2. A questionnaire was sent to the French, European and international authorities likely to have set up consumer information procedures to address a microbiological risk (listed in Annex 10 of the report).

- ***Summary of the literature***

The aim was to examine the impact of information measures on behaviour, and on a secondary level the indicators relating to the risks.

The intermediate report was based on the reading and analysis of 42 articles. In the absence of scientific publications concerning France, the Working Group focused on articles describing European or North American contexts that may be similar to the French context.

Through the literature, different information measures were identified, such as labelling, media campaigns and educational programmes. These information measures are broadly the same throughout the field of public health, both in terms of the action programmes and the communication strategies adopted, as well as the message relays involved and populations targeted.

Some research remains very general, being mainly concerned with the perception of risk among consumers (Kim, 2013; Verbeke, 2008) or with assessing how food treatment innovations are perceived (MacRitchie *et al.*, 2013; Mørkbak *et al.*, 2012). Other studies seek to measure levels of information or knowledge of good practices or pathogens, independent of any specific information campaign (Ehiri *et al.*, 1997; Koç and Ceylan, 2009; McCarthy *et al.*, 2007). Several articles are related to health crises (Arnade *et al.*, 2013; De Vocht *et al*., 2013). They seek to assess how the information provided during a health crisis episode may have been perceived and what the consequences were.

The sample also includes articles whose scope is primarily methodological. Some articles mainly contain descriptions of an information campaign, either its organisation (Redmond and Griffith, 2006a,; Redmond and Griffith, 2006b), or the implementation of an education campaign (Richards *et al.*, 2008). Others analyse communication methods, for instance by estimating the concomitant influence of television and radio, but without assessing them systematically (Dharod *et al*., 2004; McCarthy and Brennan, 2009). Yet others seek the criteria to be applied in order to correctly and effectively target the recipients of the information (Lund and O'Brien, 2011).

Regarding assessment of the information campaigns, it was found that little research focused on the effects on behaviour: Some articles assessed awareness of the information message among consumers (Faccio *et al.,* 2013); others addressed the issue of behaviour solely through statements made by respondents (Losasso *et al.*, 2012; Nauta *et al.*, 2008; Trepka *et al.*, 2008; Yarrow *et al.*, 2009). When the issue of behaviour is addressed, it is often related to purchases (purchasing intention, willingness to pay) whereas more detailed descriptions focusing on consumer practices at home may be of interest in the framework of this request (Arnade *et al.*, 2013; Conley and Wade, 2007; Dedah *et al.*, 2011; Dillaway *et al.*, 2011; Keithly Jr and Diop, 2001).

Only a few articles assessed the effects of a campaign on behaviour, i.e. the ability to reach the target, the population's interest in the information and the learning effects (Tiozzo *et al.*, 2011; Trifiletti *et al*., 2012). Others do so for actions with limited scope such as the ability to correctly prepare a chicken salad (Redmond and Griffith, 2006a; Redmond and Griffith, 2006b) or conversely by considering general campaigns on basic hygiene rules (Takanashi *et al.,* 2013). The impact of measures to prevent microbiological risks (such as appropriate storage, etc.) has also been largely overlooked in the literature, despite it being a central point of the formal request. Few of the identified studies drew directly on epidemiological data (incidence/prevalence) to assess the effects of the actions.

The body of literature investigating the impact of information about measures to control microbiological risks on behaviour therefore seems limited and cannot by itself provide clear guidelines to respond to the questions in the formal request.

- ***Review of information measures developed by health agencies***

The questionnaire yielded a response rate of around 50%. All the agencies responding believed that they contributed to informing consumers. The most common method involved placing information on the agency's website: opinions, articles, interactive question-and-answer tools or game platforms, etc.

The agencies did not have a single communication strategy. There is, in varying proportions, general information on food safety, information targeted at specific populations, and information on specific foods or types of risk. Apart from the information distributed via the websites, many agencies reported their involvement in information campaigns in schools.

Most agencies did not undertake any assessment of the information campaigns. It is true that various factors can interact with a message thereby making it difficult to assess its impact. Seven agencies reported initiatives that, while not strictly speaking constituting assessments of information campaigns, sought to better understand perceptions of the risks, the level of awareness or the behaviour of consumers. These were measures taken periodically to observe the change in these different parameters. For the most part, these studies rely on sample surveys of consumers. Thus one of their main limitations lies in the self-declarative nature of the data. Finally, three countries reported initiatives or work on the assessment of information campaigns on food risks:

- The German agency called on academics to produce reviews of knowledge, mainly on questions of methodologies from information sciences. More specifically, the BFR has a theoretical tool mainly applied to the field of nanotechnologies.
- The Italian agency, working with researchers at the University of Padua, conducted experimental research on the assessment of information campaigns. This study focused primarily on young people (pupils, students) in order to monitor the change in their behaviour or knowledge over time.

- The British agency regularly assesses its consumer information actions. The assessments concerned dissemination, website traffic and assessments of information brochures or videos (e.g. analysis of comments by users of video-sharing websites). However, the assessment of the impact on consumer behaviour remains limited: it is essentially based on self-declaration. Moreover, one of the specific aspects of the British model is the predominantly local approach of some campaigns.

- ***Methodology for developing a communication strategy for the prevention of foodborne microbiological risks***

Based on the literature data and feedback from foreign agencies, a methodology for developing a communication strategy for risk prevention can be proposed. This strategy is built around four main points:

1. The target population

Three possibilities can be considered: communicate to the entire population ("universal population"), target a part of the population concerned (e.g. young adults or individuals in a precarious situation): "selective population", or target a population at risk (such as immunocompromised patients or pregnant women): "specified population".

2. Purpose of the campaign

The second question focuses on the actual content of the message (which will be partly determined by the previous choice in terms of target). The first possibility involves focusing on a specific microbiological hazard or a food presenting a specific risk. The second possibility involves generally raising awareness about good hygiene practices able to prevent foodborne microbiological risks, by focusing the message on a hygiene measure or group of measures to be followed.

3. Type of approach for conveying information

Once the target and the content have been defined, the type of approach for conveying information can be determined according to the imbalance between the degree of risk assessed by the scientific community and the degree of risk perceived by the population. The experts propose the classification established by Food Standards Australia New Zealand (FSANZ) for its communication strategy:

- A "passive" approach is recommended when the risk is assessed as low by the scientific community. It involves preparing content and making it available to consumers seeking information. To access it, consumers must engage in a deliberate process, commensurate with their individual interest in the identified risk.
- An "active" approach (also known as interventional) is employed when the assessed risk is high and the target population has little or no awareness of it. The aim is to raise the target population’s awareness of this risk. This involves educating them and informing them of the existing preventive measures.
- The intermediate approach ("empowering") applies when the assessed risk is high and the perceived risk is also high. It involves systematically making information available and letting consumers modify their behaviour, or not, in an "enlightened" way. For instance, this is the approach used by the authorities to warn consumers of the risks associated with smoking, by reminding them systematically via labelling on cigarette packets.

There is no need for the type of approach chosen to be exclusive: several can be combined to improve the quality of the information measure.

4. The information medium

The choice of medium will depend on the type of approach chosen. Thus, in the case of an "active" approach, several vectors can be mobilised: mail/targeted mail-shot, publicity campaigns on the

television or in newspapers, information via health professionals or an education campaign that can reach the target directly. The "empowering" approach can be based on media such as labelling. In a "passive" approach, the organisation may resort to good practice data sheets made available on its website.

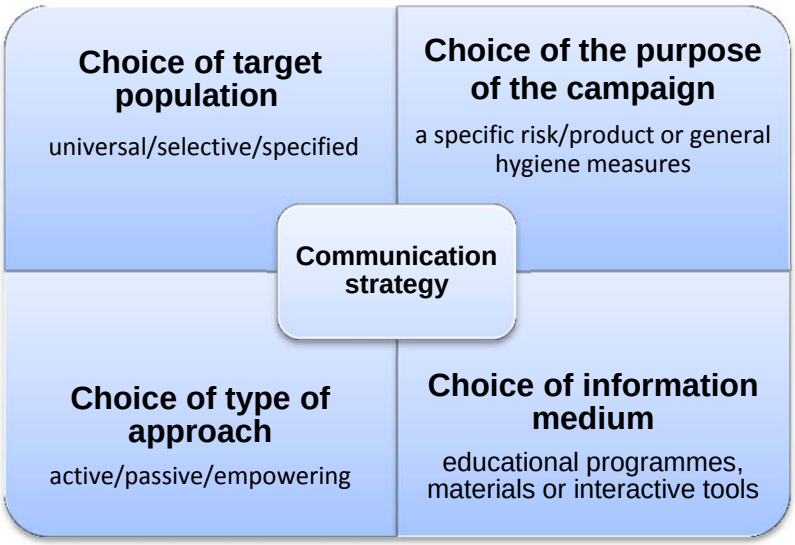

Figure 1: Summary of the iterative steps for developing a communication strategy for the prevention of microbiological risks in food

4. CONCLUSIONS OF THE COLLECTIVE EXPERT APPRAISAL

The Working Group's preliminary investigations identified:

- the hazard-food combinations for which a change in consumer practices could result in a reduction in risks (see Table 2);
- the main tools for communicating to the consumer with regard to the microbiological risks and the indicators enabling the effectiveness of the information measures to be assessed.

A more accurate assessment of the impact of the information measures on risk reduction requires a two-step quantitative approach:

- Step 1: Quantitative assessment of the impact of the measures applied by the consumer on risk reduction, taking into account the variability in consumer behaviour;
- Step 2: Assessment of the effectiveness and efficiency of the information measures on changes in consumer behaviour.

The quantitative approach also enables a comparative assessment of the impact of preventive measures applied by food business operators and consumers.

The literature review focusing on the question in the formal request, namely the impact on changes in behaviour of information aiming to reduce microbiological risks, shows that the resources are very limited, and quantifications or models that can be applied to our issue are virtually non-existent. This finding leads to the possibility of broadening the enquiry by conducting a new phase

of literature analysis on the impact of information on changes in behaviour, in the context of other types of risk, for instance in the prevention of chemical risks.

With regard to the available data, the following combinations have been selected for a quantitative assessment of the health impact of information measures:

- Shiga toxin-producing *E. coli* (STEC) / minced meat
- *L. monocytogenes* / Ready -to-eat food able to support the growth of *L. monocytogenes*
- *Campylobacter* / poultry meat

Through these three combinations, a study will be conducted of information strategies concerning four types of measures that can be applied by consumers: cooking, appropriate storage, preventing cross-contamination and avoiding consumption. This work should therefore help provide answers to issues relating to other hazard-food combinations, for example *C. botulinum* and honey.

5. AGENCY CONCLUSIONS AND RECOMMENDATIONS

The French Agency for Food, Environmental and Occupational Health & Safety endorses the CES BIORISK's conclusions.

Marc Mortureux

KEYWORDS

Consumer information; microbiological risks; hygiene.

Consumer information on prevention of biological hazards

Extracts from the Working Group's report

May 2014

Table 1 : Main biological hazards responsible for foodborne disease

Bacteria, toxins and metabolites	Parasites	Viruses	Marine biotoxins
Bacillus cereus[a] *Brucella* spp. *Campylobacter* spp. *Clostridium botulinum*[b] *Clostridium perfringens* *Cronobacter* spp. Shigatoxin-producing *Escherichia coli (STEC)* Histamine *Listeria monocytogenes* *Salmonella enterica* (non typhoid) *Shigella* spp. *Staphylococcus aureus*[c] *Vibrio parahaemolyticus* *Yersinia enterocolitica*	*Anisakis spp.* *Cryptosporidium* spp. (*Cyclospora cayetanensis* *Echinococcus multilocularis* *Fasciola hepatica* *Giardia spp.* *Taenia saginata* *Toxoplasma gondii* *Trichinella spp.*	Acute gastroenteritis viruses (mainly norovirus) Hepatitis A virus (HAV) Hepatitis E virus (HEV)	DSP[d] ASP[e] PSP[f] Ciguatoxins

[a] The illness is due to *B. cereus* strains responsible for the diarrheic symptoms or the cereulide, a toxin produced *by B. cereus* strains responsible for emetic symptoms

[b] The illness is due botulinum neurotoxins

[c] The illness is due to staphyloccal enterotoxins produced in food by coagulase-producing staphylococci, mainly *S. aureus*.

[d] Diarrheic Shellfish Poisoning is due to toxins produced by algae of *Dynophysis genus*

[e] Amnesic Shellfish Poisoning is due to toxins produced by algae of *Pseudo-nitzschia* genus

[f] Paralytic Shellfish Poisoning is due to toxins produced by algae of *Alexandrium* genus

Table 2 : Annual number of cases of foodborne diseases reported in France from 2009 to 2011

Hazards/ Disease	Annual number of reported cases			Mean annual number of cases	Data source
	2009	2010	2011		
Bacteria, toxins, or metabolites					
B. cereus	923	703	1383	1003	Mandatory notification of foodborne outbreaks
Brucella	21	20	21	21	Mandatory notification of brucellosis
Campylobacter	4026	4324	5538	4629	National reference center
C. botulinum (infant botulism)	2	0	1	1	Mandatory notification of botulism
C. botulinum (intoxication)	27	24	16	22	Mandatory notification of botulism
C. perfringens	1592	883	1697	1391	Mandatory notification of foodborne outbreaks
Cronobacter	0	0	0	0	Surveillance of nosocomial infections
STEC (HUS)	109	122	162	131	Haemolyitic Uremic Syndrome surveillance network
Histamine	208	117	138	154	Mandatory notification of foodborne outbreaks
L. monocytogenes	328	307	276	304	Mandatory notification of listeriosis
Salmonella (non typhoid)	9777	9224	10923	9975	National reference center
Shigella	44	14	11	23	Mandatory notification of foodborne outbreaks
S. aureus	1723	2027	2183	1978	Mandatory notification of foodborne outbreaks
V. parahaemolyticus	3	2	0	2	Mandatory notification of foodborne outbreaks
Y. enterocolitica	208	225	282	238	National reference center
Viruses					
Acute gastroenteritis viruses	1890	1347	1291	1509	Mandatory notification of foodborne outbreaks
HAV	1547	1244	1114	1302	Mandatory notification of hepatitis A
HEV (autochtonous infections)	183	216	249	216	National reference center Mandatory notification of foodborne outbreaks
Parasites					
Anisakis	no surveillance				
Cryptosporidium	135	70	78	94	*Cryptosporidium* national network
C. cayetanensis	13	7	6	9	*Cryptosporidium* national network
E. multilocularis	22	14	21	18	National reference center
F. hepatica	no surveillance				
Giardia	442	582	407	477	National reference center
T. saginata	No surveillance				
T. gondii (congenital form)	266	244	186	232	National reference center
Trichinella	9	0	2	4	National reference center
Marine biotoxins					
DSP	82	118	24	75	Mandatory notification of foodborne outbreaks
ASP	4	0	0	1	Mandatory notification of foodborne outbreaks
PSP	0	0	0	0	Mandatory notification of foodborne outbreaks
Ciguatoxin	16	26	13	18	Mandatory notification of foodborne outbreaks

Table 3 : Summary of the food-hazard combinations

Food Category	Food sub-category	Specific food	Hazards
Meat	Beef[a]	Minced beef	STEC, *Salmonella*
			T. saginata
	Poultry[a]		*Campylobacter, Salmonella*
	Pork[a]		*Y. enterocolitica*
		Raw pork liver products, wild boar offal	HEV
		Meat of pigs reared outdoors, wild boar meat, game meat	*Trichinella*
		Home-made delicatessen meats	*C. botulinum*
	Other meats	Meats (lamb, pigs reared outdoors, imported horse meat)	*T. gondii*
Dairy products	Raw milk		*Brucella, STEC*
	Raw-milk cheeses	Unripened cheeses	*Brucella*
		uncooked pressed cheeses	*Salmonella*
		Soft cheeses	*E. coli STEC, Salmonella, S. aureus*
	Infant milk reconstituted from powdered infant formula		*Cronobacter, Salmonella*
Seafood	Fish		*Anisakis*, ciguatoxine
		Fish with high histidine content (mainly tuna)	Histamine
	Crustacean		*V. parahaemolyticus*
	Shellfish		*V. parahaemolyticus*, AGE viruses, VHA, DSP, ASP, PSP
Raw vegetables		Raw fruits and vegetables including frozen (red fruits, crudités)	AGE viruses, HAV
		Non frozen	*STEC, Salmonella, Cryptosporidium, C. cayetanensis, Giardia, T. gondii*
		Wild raw vegetables (watercress, dandelion)	*F. hepatica*
		Red fruits and berries	*E. multilocularis*
Eggs and eggs products		Raw eggs and egg-based products	*Salmonella*
Cooked meals and delicatessen products	Refrigerated cooked meals		*B. cereus*
		Refrigerated vacuum-packed cooked meals	*C. botulinum*
	Home-made cooked meals	Especially those containing cereals cooked in water (pasta, rice, semolina) or dehydrated ingredients	*B. cereus*
		Especially meat in gravy	*C. perfringens*
	Delicatessen products	Cooked meals, pastries, delicatessen meats, sandwiches	*S. aureus*
	Home-made preserves		*C. botulinum*
Ready to eat foods	Heavily handled	Sandwiches	*Shigella*, AGE viruses, HAV
	Able to support the growth of *L. monocytogenes*[b]	Cooked delicatessen meats, soft cheeses, smoked fish, raw vegetables, etc.	*L. monocytogenes*
Honey			*C. botulinum*

[a] Fresh meat, meat preparations, meat products.

[b] Ready-to-eat foods able to support the growth of *L. monocytogenes*, are those belonging to food category 1.2 of Regulation (EC) n° 2073/2005.Given the variety of foods involved, these are regrouped within the same subcategory.

Table 4 : Incidence of foodborne diseases (cases per 100,000 inhabitants): attributed scores, surveillance data and incidence estimates

Hazards	Surveillance data			Estimates								Incidence scores
	France 2009-2011		EU 2010	France 90's (Vaillant et al., 2005)		Netherlands 2009 (Havelaar et al., 2012)		USA 2000-2008 (Scallan et al., 2011)		Canada 2000-2010 (Thomas et al., 2013)		
	Mean annual number of cases	Incidence	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	
Bacteria, toxins, or metabolites												
B. cereus	1003	1,54		460	0,78	50000	303	63400	21,2	36269	112	4
Brucella	21	0,03	0,07	80	0,14			839	0,28	22	0,07	1
Campylobacter	4629	7,12	48,6	15059	25,5	92000	558	845024	283	145350	447	4
C. botulinum (infant botulism)	1	0,00										0
C. botulinum (intoxication)	22	0,03		22	0,04			55	0,02	14	0,04	1
C. perfringens	1391	2,14		5859	9,93	168000	1018	965958	323	176963	545	4
Cronobacter	0	0,00										0
STEC (HUS)	131	0,20	0,83	560	0,95	22 (a)	0.13 (a)	175905 (b)	58.8 (b)	33350 (b)	103 (b)	2
Histamine	154	0,24										2
L. monocytogenes	304	0,47	0,40	304	0,52	79	0,48	1591	0,53	178	0,55	2
*Salmonella (*non typhoid)	9975	15,35	21,5	35868	60,8	35000	212	1027561	344	87510	269	4
Shigella	23	0,04		196	0,33					1202	3,70	1
S. aureus	1978	3,04		6839	11,6	292000	1770	241148	80,7	25110	77,3	4
V. parahaemolyticus	2	0,00						34664	11,6	1798	5,53	1
Y. enterocolitica	238	0,37	1,58	1282	2,17			97656	32,7	25915	79,7	3
Viruses												
Acute gastroenteritis viruses	1509	2,32		70194	119	624000	3782	5461731	1827	1047733	3224	5
HAV	1302	2,00		406	0,69	862	5,22	1566	0,52	271	0,83	2
HEV (autochtonous infections)	216	0,33				53	0,32					2
Parasites												
Anisakis				8	0,01							1
Cryptosporidium	94	0,15				28000	170	57616	19,3	2321	7,14	2
C. cayetanensis	9	0,01						11407	3,82	2450	7,54	0

Hazards	Surveillance data			Estimates								Incidence scores
	France 2009-2011		EU 2010	France 90's (Vaillant et al., 2005)		Netherlands 2009 (Havelaar et al., 2012)		USA 2000-2008 (Scallan et al., 2011)		Canada 2000-2010 (Thomas et al., 2013)		
	Mean annual number of cases	Incidence	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	Mean annual number of cases	Incidence	
E. multilocularis	19	0,03										1
F. hepatica												0
Giardia	477	0,73				83000	503	76840	25,7	7776	23,9	2
T. saginata				65000	110							3
T. gondii (congenital form)	232	0,36	0,60	51655 (c)	87.6 (c)	373	2,26	86686 (c)	29.0 (c)	9132 (c)	28.1 (c)	2
Trichinella	4	0,01	0,05	40	0,07			156	0,05	63	0,19	1
Marine biotoxins												
DSP	75	0,11										2
ASP	1	0,00										1
PSP	18	0,03										1

(a) HUS linked to E. coli O157

(b) STEC infections with or without HUS complication

(c) Toxoplasmosis cases in the general population

Table 5 : Attributed scores for the severity of the diseases associated with the hazards

Hazards	DALY (years per 1000 cases) (Havelaar et al., 2012)	Score based on DALY	Score based on expert opinion	Severity score
Bacteria, toxins, or metabolites				
B. cereus	2,3	1		1
Brucella	/	/	2	2
Campylobacter	41	2		2
C. botulinum (infant botulism)	/	/	4	4
C. botulinum (intoxication)	/	/	3	3
C. perfringens	3,2	1		1
Cronobacter	/	/	4	4
STEC (HUS)	143	3	4 [a]	4
Histamine	/	/	1	1
L. monocytogenes	1450	4		4
*Salmonella (*non typhoid)	49	2		2
Shigella	/	/	2	2
S. aureus	2,6	1		1
V. parahaemolyticus	/	/	1	1
Y. enterocolitica	/	/	2	2
Viruses				
Acute gastroenteritis viruses	2,4	1		1
HAV	167	3		3
HEV (autochtonous infections)	460	3		3
Parasites				
Anisakis	/	/		1
Cryptosporidium	2,9	1		1
C. cayetanensis	/	/	1	1
E. multilocularis	/	/	4	4
F. hepatica	/	/	2	2
Giardia	2,1	1		1
T. saginata	/	/	1	1
*T. gondii (*congenital form)	6360	4		4
Trichinella		1	2	2
Marine biotoxins				
DSP	/		1	1
ASP	/		3	3
PSP	/		3	3

[a] The DALY estimated by Havelaar et al (2012) is related to STEC infections. A score of 4 is proposed by the experts for the severity of the HUS.

Table 6 : Effectiveness of the preventive measures on the hazard-food combinations

Table 6a: **Preventing cross-contamination - Washing and decontaminating fruits and vegetables**

Combination		Preventing cross-contamination	Washing and decontaminating fruits and vegetables
Hazard	Foods		
E. coli STEC	Raw fruits and vegetables	1	1
Salmonella	Raw fruits and vegetables	1	1
Campylobacter	Poultry meat	1	NA[a]
E. coli STEC	Minced beef, raw-milk cheese	1	NA
Salmonella	Raw-egg-based products, meats, raw milk cheese	1	NA
Shigella	Food handled at home prior to consumption	1	NA
Y. enterocolitica	Pork	1	NA
Acute gastroenteritis viruses	Food handled at home prior to consumption	1	NA
HAV	Food handled at home prior to consumption	1	NA
Anisakis	Fish	1[b]	NA
Cryptosporidium	Raw fruits and vegetables	0	1
E. multilocularis	Red fruits and berries	0	1
Giardia	Raw fruits and vegetables	0	1
T. gondii	Raw fruits and vegetables	0	1

[a] NA, not applicable ; [b] rapid evisceration after capture

Table 6b : **Freezing and cooking**

Combination		Deep freezing	Cooking
Hazard	Foods		
Anisakis	Cooked fish	2	2
T. saginata	Beef	2	2
T. gondii	Meat	2	2
Anisakis	Raw fish	2	NA
Cryptosporidium	Raw fruits and vegetables	2	NA
Giardia	Raw fruits and vegetables	2	NA
E. multilocularis	Red fruits and berries	1	2
Trichinella	Meat of pigs reared outdoors, wild boar meat, game meat	1	2
C. cayetanensis	Raw fruits and vegetables	1	NA
F. hepatica	Wild raw vegetables	1	NA
T. gondii	Raw fruits and vegetables	0	NA
Campylobacter	Poultry meat	0	2
C. botulinum (intoxication)	Home-made preserves	0	2
C. botulinum (intoxication)	Refrigerated vacuum-packed cooked meals	0	2
Cronobacter	Infant milk reconstituted from powdered infant formula	0	2
E. coli STEC	Cooked minced beef, raw milk	0	2
Salmonella	Meats, Infant milk reconstituted	0	2
V. parahaemolyticus	Cooked shellfish and crustacean	0	2
Y. enterocolitica	Pork	0	2
HEV	Raw pork liver products, wild boar offal	0	2
B. cereus	Home-made cooked meals	0	1[c]
C. perfringens	Home-made cooked meals	0	1[c]
Acute gastroenteritis viruses	Cooked shellfish	0	1
HAV	Cooked shellfish	0	1
Brucella	Raw milk	NA	2
Salmonella	Eggs	NA	2

[c] : Reheating for home-made cooked meals

Table 6c : **Respecting the cold chain and the use-by date**

Combinations		Respecting the cold chain and the use-by date
Hazard	Food	
B. cereus	Refrigerated or home-made cooked meals	2
C. botulinum (intoxication)	Refrigerated vacuum-packed cooked meals	2
C. perfringens	Home-made cooked meals	2
Cronobacter	Infant milk reconstituted from powdered infant formula	2
S. aureus	Delicatessen products	2
C. botulinum (intoxication)	Home-made delicatessen meats	1
L. monocytogenes	Ready-to-eat foods able to support the growth of *L. monocytogenes*	1
Salmonella	Eggs products, meats, raw milk cheese, infant milk reconstituted	1
V. parahaemolyticus	Raw shellfish	1
Y. enterocolitica	Pork	1

Table 6d : **Rapid cooling**

Combinations		Rapid cooling
Hazard	Foods	
B. cereus	Home-made cooked meals	2
C. botulinum (intoxication)	Home-made preserves and delicatessen meats	2
C. perfringens	Home-made cooked meals	2
Cronobacter	Infant milk reconstituted from powdered infant formula	2
S. aureus	Delicatessen products	2
Salmonella	Infant milk reconstituted from powdered infant formula	1

Table 6e : Avoiding consumption of the food by susceptible population groups

Combinations		Avoiding consumption	Population groups targeted by the measure	Effectiveness of other preventive measures	
Hazard	Foods				
C. botulinum (infant botulism)	Honey	2	Infants (< 12 months old)	-	0
E. coli STEC	Raw minced beef, soft raw-milk cheeses	2	Young children	Preventing cross-contamination	1
E. coli STEC	Raw milk	2	Young children	Cooking	2
L. monocytogenes	Ready-to-eat foods able to support the growth of *L. monocytogenes*	2	Pregnant women Elderly people Immunocompromised subjects	Respecting the cold chain and the use-by date	1
HEV	Raw pork liver products, wild boar offal r	2	People with an underlying liver condition Immunocompromised subjects pregnant women	Cooking	2
Cryptosporidium	Raw fruits and vegetables	2	Immunocompromised subjects	Deep freezing	2
T. gondii	Raw fruits and vegetables	2	Pregnant women	Washing and decontaminating	1

Appendix 4 : Attributed scores for the effectiveness of the preventive measures applied by the consumer on each hazard-food combination

Combinations		Preventing cross-contamination	Washing and decontaminating fruits and vegetables	Rapid cooling	Deep freezing	Cooking (including reheating)	Respecting the cold chain and the use-by date	Overall impact on risk	Avoiding consumption	Population groups targeted by the measure	Overall impact on the risk (including avoiding consumption by vulnerable populations)
Hazard	Food										
B. cereus	Refrigerated cooked meals	0	NA	0	0	NA	2	2	NA		2
B. cereus	Home-made cooked meals	0	NA	2	0	1	2	2	NA		2
Brucella	Unripened raw-milk cheeses	0	NA	NA	0	NA	0	0	NA		0
Brucella	Raw milk	0	NA	NA	NA	2	0	2	NA		2
Campylobacter	Poultry meat	1	NA	0	0	2	0	2	NA		2
C. botulinum (infant botulism)	Honey	NA	NA	NA	NA	NA	0	0	2	Infants under 12 months old	2
C. botulinum (intoxication)	Home-made preserves	NA	NA	2[a]	0	2	NA	2	NA		2
C. botulinum (intoxication)	Home-made delicatessen meats	NA	NA	2[a]	NA	NA	1	2	NA		2
C. botulinum (intoxication)	Refrigerated vacuum-packed cooked meals	0	NA	0	0	2	2	2	NA		2
C. perfringens	Home-made cooked meals	0	NA	2	0	1	2	2	NA		2
Cronobacter	Infant milk reconstituted from powdered infant formula	0	NA	2	0	2	2	2	NA		2
E. coli STEC	Cooked minced beef	1	NA	NA	0	2	0	2	NA		2
E. coli STEC	Raw minced beef	1	NA	NA	0	NA	0	1	2	Young children	2

Combinations		Preventing cross-contamination	Washing and decontaminating fruits and vegetables	Rapid cooling	Deep freezing	Cooking (including reheating)	Respecting the cold chain and the use-by date	Overall impact on risk	Avoiding consumption	Population groups targeted by the measure	Overall impact on the risk (including avoiding consumption by vulnerable populations)
Hazard	Food										
E. coli STEC	Soft raw-milk cheeses	1	NA	NA	0	NA	0	1	2	Young children	2
E. coli STEC	raw milk	NA	NA	NA	0	2	0	2	2	Young children	2
E. coli STEC	Raw fruits and vegetables	1	1	NA	0	NA	0	1	NA		1
Histamine	Fishes with high histidine content	0	NA	0	0	0	0	0	NA		0
L. monocytogenes	Ready-to-eat foods able to support the growth of *L. monocytogenes*	0	NA	NA	0	NA	1	1	2	Pregnant women Immunocompromised subjects	1
Salmonella	Eggs	0	NA	NA	NA	2	0	2	NA		2
Salmonella	Raw egg-based products	1	NA	NA	0	NA	1	1	NA		1
Salmonella	Meats	1	NA	0	0	2	1	2	NA		2
Salmonella	Raw-milk cheeses	1	NA	NA	0	NA	1	1	NA		1
Salmonella	Infant milk reconstituted from powdered infant formula	0	NA	1	0	2	1	2	NA		2
Salmonella	Raw fruits and vegetables	1	1	NA	0	NA	0	1	NA		1
Shigella	Food handled at home prior to consumption	1	NA	NA	0	NA	0	1	NA		1
S. aureus	Delicatessen products	0	NA	2	0	0	2	2	NA		2
S. aureus	Soft raw-milk cheeses	0	NA	NA	0	NA	0	0	NA		0
V. parahaemolyticus	Cooked shellfish and crustacean	0	NA	NA	0	2	0	2	NA		2
V. parahaemolyticus	Raw shellfish	0	NA	NA	0	NA	1	1	NA		1

Combinations		Preventing cross-contamination	Washing and decontaminating fruits and vegetables	Rapid cooling	Deep freezing	Cooking (including reheating)	Respecting the cold chain and the use-by date	Overall impact on risk	Avoiding consumption	Population groups targeted by the measure	Overall impact on the risk (including avoiding consumption by vulnerable populations)
Hazard	Food										
Y. enterocolitica	Pork	1	NA	0	0	2	1	2	NA		2
Acute Gastroenteritis viruses	Cooked shellfish	0	NA	NA	0	1	0	1	NA		1
Acute Gastroenteritis viruses	Raw shellfish	0	NA	NA	0	NA	0	0	NA		0
Acute Gastroenteritis viruses	Raw fruits and vegetables (included frozen)	0	0	NA	0	NA	0	0	NA		0
Acute Gastroenteritis viruses	Food handled at home prior to consumption	1	NA	NA	0	NA	0	1	NA		1
HAV	Cooked shellfish	0	NA	NA	0	1	0	1	NA		1
HAV	Raw shellfish	0	NA	NA	0	NA	0	0	NA		0
HAV	Raw fruits and vegetables (included frozen)	0	0	NA	0	NA	0	0	NA		0
HAV	Food handled at home prior to consumption	1	NA	NA	0	NA	0	1	NA		1
HEV	Raw pork liver products, wild boar offal	0	NA	NA	0	2	0	2	2	Pregnant women Immunocompromised subjects People with liver condition	2
Anisakis	Raw fish	1[b]	NA	NA	2	NA	0	2	NA		2
Anisakis	Cooked fish	1[b]	NA	NA	2	2	0	2	NA		2
Cryptosporidium	Raw fruits and vegetables	0	1	NA	2	NA	0	2	2	Immunocompromised	2

Combinations		Preventing cross-contamination	Washing and decontaminating fruits and vegetables	Rapid cooling	Deep freezing	Cooking (including reheating)	Respecting the cold chain and the use-by date	Overall impact on risk	Avoiding consumption	Population groups targeted by the measure	Overall impact on the risk (including avoiding consumption by vulnerable populations)
Hazard	Food										
										subjects	
C. cayetanensis	Raw fruits and vegetables	0	0	NA	1	NA	0	1	NA		1
Echinococcus multilocularis	Red fruits and berries	0	1	NA	1	2	0	2	NA		2
F. hepatica	Wild raw vegetables	0	0	NA	1	NA	0	1	NA		1
Giardia	Raw fruits and vegetables	0	1	NA	2	NA	0	2	NA		2
T. saginata	Beef	0	NA	NA	2	2	0	2	NA		2
T. gondii	Meats	0	NA	NA	2	2	0	2	NA	Pregnant women	2
T. gondii	Raw fruits and vegetables	0	1	NA	0	NA	0	1	2	Pregnant women	2
Trichinella	Meat of pigs reared outdoors, wild boar meat, game meat	0	NA	0	1	2	0	2	NA		2
Marine biotoxins (DSP)	Shellfish	0	NA	NA	0	0	0	0	NA		0
Marine biotoxins (ASP, PSP)	Shellfish	0	NA	NA	0	0	0	0	NA		0
Ciguatoxin	Fish	0	0	0	0	0	0	0	NA		0

[a] Control of preparation conditions (sterilization, salting, drying)

[b] Rapid evisceration after capture

Appendix 5 : Ranking of the hazard-food combinations according to their public health impact and the potential impact of the consumer

Hazard	Food	Public Health impact score	Rank	Overall impact of the preventive measures on the risk	Overall impact of the preventive measures (including avoiding consumption by vulnerable populations**) on the risk
E. coli STEC	Cooked minced beef	6	1	2	2
E. coli STEC	Raw milk	6	1	2	2
T. gondii	Meats	6	1	2	2
Campylobacter	Poultry meat	6	1	2	2
Salmonella	Eggs	6	1	2	2
Salmonella	Meats	6	1	2	2
Salmonella	Infant milk reconstituted from powdered infant formula	6	1	2	2
Echinococcus multilocularis	Red fruits and berries	5	7	2	2
HEV	Raw pork liver products, wild boar offal	5	7	2	2
Y. enterocolitica	Pork	5	7	2	2
B. cereus	Refrigerated cooked meals	5	7	2	2
B. cereus	Home-made cooked meals	5	7	2	2
C. perfringens	Home-made cooked meals	5	7	2	2
S. aureus	Delicatessen products	5	7	2	2
Cronobacter	Infant milk reconstituted from powdered infant formula	4	14	2	2
C. botulinum (intoxication)	Home-made preserves	4	14	2	2
C. botulinum (intoxication)	Home-made delicatessen meats	4	14	2	2
C. botulinum (intoxication)	Refrigerated vacuum-packed cooked meals	4	14	2	2
T. saginata	Beef	4	14	2	2
Brucella	Raw milk	3	20	2	2
Trichinella	Meat of pigs reared outdoors, wild boar meat, game meat	3	20	2	2
Cryptosporidium	Raw fruits and vegetables	3	20	2	2
Giardia	Raw fruits and vegetables	3	20	2	2
V. parahaemolyticus	Cooked shellfish and crustacean	2	27	2	2
Anisakis	Raw fish	2	27	2	2
Anisakis	Cooked fish	2	27	2	2
E. coli STEC	Raw minced beef	6	1	1	2
E. coli STEC	Soft raw-milk cheeses	6	1	1	2
T. gondii	Raw fruits and vegetables	6	1	1	2
E. coli STEC	Raw fruits and vegetables	6	1	1	1
L. monocytogenes	Ready-to-eat foods able to support the growth of *L. monocytogenes*	6	1	1	1
Salmonella	Raw-egg-based products	6	1	1	1
Salmonella	Raw-milk cheeses	6	1	1	1
Salmonella	Raw fruits and vegetables	6	1	1	1
Acute Gastroenteritis	Cooked shellfish	6	1	1	1

Hazard	Food	Public Health impact score	Rank	Overall impact of the preventive measures on the risk	Overall impact of the preventive measures (including avoiding consumption by vulnerable populations**) on the risk
viruses					
Acute Gastroenteritis viruses	Food handled at home prior to consumption	6	1	1	1
HAV	Cooked shellfish	5	7	1	1
HAV	Food handled at home prior to consumption	5	7	1	1
Shigella	Food handled at home prior to consumption	3	20	1	1
F. hepatica	Wild raw vegetables	2	27	1	1
V. parahaemolyticus	Raw shellfish	2	27	1	1
C. cayetanensis	Raw fruits and vegetables	1	30	1	1
C. botulinum (infant botulism)	Honey	4	14	0	2
Acute Gastroenteritis viruses	Raw shellfish	6	1	0	0
Acute Gastroenteritis viruses	Raw fruits and vegetables (included frozen)	6	1	0	0
HAV	Raw shellfish	5	7	0	0
HAV	Raw fruits and vegetables (included frozen)	5	7	0	0
S. aureus	Soft raw-milk cheeses	5	7	0	0
Marine biotoxins (ASP, PSP)	Shellfish	4	14	0	0
Ciguatoxin	Fish	4	14	0	0
Brucella	Unripened raw-milk cheeses	3	20	0	0
Histamine	Fish with high histidine content	3	20	0	0
Marine biotoxins (DSP)	Shellfish	3	20	0	0