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Food Safety: Consumer Perceptions and Practices
Anne Wilcock\textsuperscript{1} and Brita Ball\textsuperscript{2}
\textsuperscript{1}Department of Marketing and Consumer Studies, University of Guelph, Ontario, Canada
\textsuperscript{2}Department of Food Science, University of Guelph, Ontario, Canada

Summary
We describe the knowledge, attitudes and behaviors of consumers regarding food safety, as well as social, cultural, economic and demographic factors that influence consumer attitudes and behavior. Consumer perspectives associated with the benefits and risks of technologies such as irradiation, genetic modification, nanotechnology, use of hormones in food animals and organic foods are discussed. In recent years, substantial resources have been devoted to increasing the level of food safety knowledge among consumers. The emphasis of such consumer education should be placed on behaviors that have the greatest impact on reducing risk of foodborne illness.

2.1 Introduction
Consumers have a wide range of choices among foods that are competitively priced based on their quality attributes. Consumers look for qualities that meet their needs. Aesthetic, organoleptic and healthful qualities, as well as the product and brand image, influence their choices. In addition to the food meeting their quality preferences, consumers expect it to be intrinsically safe (Grunert, 2005; Lobb, 2005; Verbeke \textit{et al.}, 2007; van Rijswijk and Frewer, 2008).

Foodborne diseases affect millions of people each year. The World Health Organization identified that the burden of foodborne disease is largely unknown, so initiated a collaborative effort to assess the worldwide foodborne disease problem. This includes diseases associated with biological and chemical contaminants (WHO, 2012).
Some countries have produced their own estimates. In England and Wales, 1.7 million cases of domestically acquired foodborne diseases are estimated to occur annually (Adak et al., 2005). In the United States, an estimated 9.4 million domestically acquired cases of foodborne diseases are caused by 31 major pathogens (Scallan et al., 2011a) and 38.4 million are attributed to unspecified agents (Scallan et al., 2011b). The Public Health Agency of Canada estimated that 4 million cases of domestically acquired foodborne disease occur each year in Canada; 1.6 million of these are caused by 30 pathogens and 2.4 million incidents of acute gastrointestinal illness are attributed to unspecified agents (Thomas et al., 2013). These statistics more accurately represent the estimates of acute gastrointestinal illnesses per year in the United States (Mead et al., 1999) and in Canada (Thomas et al., 2008).

Difficulties in making accurate estimates include the under-reporting of known food-related diseases, the transmission of food-related pathogens through non-food sources and unrecognized agents in food (Wilcock et al., 2004). Furthermore, long-term health effects are not captured in these estimates. In addition, illness or disease may stem from chemical contamination such as allergens, naturally occurring toxins (e.g. mycotoxins), industrial pollutants (e.g. dioxin), agricultural chemicals (e.g. pesticides and antimicrobials) or other compounds.

The consequences of a contaminated food supply, as well as inadequate hygiene and food handling practices that increase food risks, are substantial. The economic burden of foodborne disease can be associated with medical costs related to consumer illness and death, productivity loss, loss of customers and sales and associated lawsuits (Buzby et al., 1996). Economic costs are also associated with loss of consumer confidence in the food industry, lost production (Wilcock et al., 2004; Lewis et al., 2013) and, potentially, lost jobs. ‘Hidden’ costs include pain and suffering, time spent by caregivers and travel-associated costs for those affected and their caregivers (Nyachuba, 2010). The 2008–2009 *Salmonella* Typhimurium outbreak associated with peanut products produced by the Peanut Corporation of America, for example, led to 716 identified illnesses and 9 deaths in 46 US states and Canada, and an international recall of 3918 peanut butters and peanut-butter-containing foods manufactured by various companies (CBC, 2009; Cavallaro et al., 2011). Production facilities were shut down. Subsequently, four former officials of the bankrupt company were criminally charged, and $12 million was awarded to the victims (Goetz, 2013).

Governments at various levels have recognized the risk and potential impact of food contamination. In Britain, the 1990 Food Safety Act and the 1995 General Hygiene Act significantly affected the food safety risk management practices in the food sector, shifting the focus from fraud prevention to a proactive scientific-based food safety approach (Sackett, 1991). The Food Standards Agency, created in the UK in 2000, included a mandate to conduct retail food surveillance and coordinate food safety research (Tent, 1999). Soon after, the European Parliament enacted the General Food Law Regulation which established the European Food Safety Authority and required member countries to adapt their laws by 2007 to comply with Regulation EC/178/2002 (European Commission, 2002). In the United States in 1997, then President Clinton launched a National Food Safety initiative to enhance surveillance, improve risk assessment, inspection and compliance, educate consumers and conduct important new research (Tent, 1999). Food safety standards have continued to improve with the introduction of various rules and guidance documents, as well as the Food Safety Modernization Act brought into force by President Obama in 2011 (USFDA, 2013).

Reforms introduced with the latter legislation focus on preventing contamination of the food supply, rather than reacting to contamination issues (USFDA, 2013). Similarly, the Government of Canada, responding to recommendations put forth in the Weatherill Report following a nationwide listeriosis outbreak in 2008, passed the Safe Food for Canadians Act in 2012. This statute brings together several pieces of legislation to strengthen the oversight of food that is subject to federal laws, thereby enhancing the safety of
the food supply (CFIA, 2012). Many other countries have adopted legislation to protect consumers and the food supply. Recently, China consolidated food safety standards and introduced more than 300 new standards through the China National Center for Food Safety Risk Assessment. Plans are to introduce a single set of food safety standards by 2015 (Xiaodong, 2013).

The implementation of regulations, good manufacturing practices (GMP) and hazard analysis critical control point (HACCP) systems in processing facilities are essential to reduce the risk of biological, chemical and physical contamination. As consumers are unable to make a clear distinction between food quality and safety, when they perceive product quality they expect the food to be safe (van Rijswijk and Frewer, 2008). Despite consumers’ expectations, zero food risk is not however possible (Lobb, 2005).

Consumers’ attitudes and practices related to food safety are themes of interest to food producers and retailers, public authorities and health educators. This interest has been reflected in discussions about how food safety should be defined and how consumers perceive food safety and choose food. This chapter provides an overview of consumer perceptions about what constitutes safe food and safe food handling practices. It is an update of an article by Wilcock et al. (2004), expanding the section on novel technologies and hormone use and adding information about deliberate and accidental food contamination. Moreover, we discuss the relationship between consumer perception, food risk and the impact on attitude and practices.

2.2 Novel technologies and issues

A safe food is food that is free of all hazards. Henson and Traill (1993) suggest food safety can be viewed as the inverse of food risk; that is, the probability of not experiencing a negative health outcome from consuming a food. Consumers may see it simply as food that is harmless to health (Jevšnik et al., 2008). Novel technologies used in food production and processing can be introduced to the market after government approvals that consider food safety and other factors. Taking different approaches to risk analysis, some governments may not approve controversial technologies that other governments accept. Moreover, some consumers may mistrust a technology or may hold attitudes or philosophical perspectives that lead them to reject some foods that other consumers will choose. An overview of consumer concerns about controversial technologies is provided in Table 2.1. When examining consumers’ attitudes towards food safety, it is important to consider

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<tr>
<th>Technology</th>
<th>Consumer concerns</th>
<th>Food safety</th>
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<tr>
<td>Irradiation (to reduce pathogens and pest contamination, increase shelf-life)</td>
<td>Safety, environmental safety</td>
<td>Low risk, permitted use varies among countries</td>
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<tr>
<td>Hormone supplementation for food animals (to aid livestock production)</td>
<td>Safety, lack of consumer benefit</td>
<td>Assessment of risk mixed, permitted use varies among countries</td>
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<td>Genetic modification (to create desired traits in plants and animals through genetic manipulation such as cross-breeding, mutagenesis or biotechnology)</td>
<td>Safety, potential negative social and economic outcomes, potential negative environmental outcomes, consumer choice/consent</td>
<td>Assessment of risk mixed, permitted use varies among countries, food labeling varies among countries</td>
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<th>Technology</th>
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<td>Genetic engineering, an aspect of genetic modification (to create</td>
<td>Safety, potential negative social and economic outcomes, potential negative</td>
<td>Some transgenic plants approved for food and/or feed in some countries,</td>
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<td>desired traits in plants and animals through genetic manipulation</td>
<td>environmental outcomes, consumer choice/consent</td>
<td>transgenic animals not approved for use</td>
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<td>involving recombinant DNA or genetic engineering techniques</td>
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<td>Nanotechnology (to enhance food characteristics such as safety, quality,</td>
<td>Consumer benefits versus risks, potential negative health and environmental</td>
<td>Risks largely unknown, gaps in knowledge and regulatory frameworks for</td>
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<td>structure, taste, texture, color and nutrition)</td>
<td>outcomes, unknown outcomes, consumer choice/consent</td>
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attitudes towards controversial technologies and issues that may affect foods.

#### 2.2.1 Irradiation

Irradiation is a technology discovered a century ago when an ionizing radiation process to improve food quality was patented in the United Kingdom (O’Bryan et al., 2008). In 1983, the Codex Alimentarius Commission recognized the safety and viability of irradiation for foods; the World Health Organization (1994, 1999) confirmed their safety and wholesomeness. Report after report emphasizes the effectiveness of irradiation: the process of exposing food to a carefully controlled amount of ionizing energy to reduce the microbial risk associated with raw and minimally processed foods including meat, seafood, fruit, vegetables, grains and spices. It is also used to reduce spoilage or sprouting.

Molins et al. (2001) equate the public health value of irradiating foods to that of thermal pasteurization of milk, which is mandatory in many countries. Irradiation, sometimes referred to as cold pasteurization, can effectively destroy bacteria and parasites, but not viruses (O’Bryan et al., 2008). With Campylobacter and Salmonella as two of the top agents causing foodborne disease in the US, Canada and parts of the United Kingdom (Adak et al., 2005; Scallan et al., 2011a; Thomas et al., 2013), irradiation of poultry products alone has the potential to considerably reduce the associated public health and economic burdens.

Quality concerns formerly associated with irradiated meat, resulting from oxidation and the production of toxic compounds, have been reduced by adjustments in temperature, additives (such as vitamin E) and atmosphere during irradiation. Sensory panels have been unable to distinguish between irradiated and non-irradiated meats, or the irradiated meat was identified but maintained an acceptable quality (O’Bryan et al., 2008). Additionally, with food safety management systems commonly required in processing establishments, consumers ought to be less concerned now than in the past about the potential use of irradiation technology to compensate for poor product quality and/or poor manufacturing and unhygienic practices. According to Brewer and Rojas (2008), more than one-third of US consumers had no to low concern about irradiated foods (17.7% and 21.1%, respectively), while nearly as many were strongly or very strongly concerned (19.8% and 17.5%, respectively). Interestingly, this represents a shift of consumer perception in an earlier study (Brewer and Prestat, 2002) from having no/low concern to being moderately concerned. The reason for this shift is not clear, although overall consumer confidence in the food they eat decreased by 10%.
Consumers who were given information on the irradiation process and participated in market trials of irradiated products were much more likely to accept this technology. In 1991, a small food store in Chicago held one of the most successful trials in the US. Irradiated strawberries, oranges and grapefruits outsold the non-irradiated fruits by a ratio of 9:1. The following season, irradiated strawberries outsold non-irradiated strawberries by 20:1. This phenomenon encouraged approximately 60 stores in Indiana, Illinois and Ohio to sell a variety of irradiated foods (Bruhn, 1995).

Studies by Bruhn (1995, 1998) consistently show that a high percentage of consumers who are informed about the science will prefer irradiated foods. Consumers in focus group discussions identified three important messages: the safety and wholesomeness of irradiated food, the effectiveness of the process to destroy bacteria and protect against foodborne illness and the safety endorsement by health authorities (Bruhn, 1998). Statements from the American Dietetic Association and the American Medical Association demonstrate professional support from credible sources that have an interest in public health. These organizations see their role as assisting in the education of consumers about the technology (IPST, 1999). As such, they can help to educate consumers on the advantages and limitations of the technology to enable consumers to make informed and rational decisions about buying and eating irradiated food (Bruhn, 1998).

Despite consumers showing positive response about irradiated foods when given information from scientific sources, Fox et al. (2002) identified that negative information reduced the effect. When consumers were given positive expert information balanced with negative information from consumer advocacy groups, the positive effect of the expert messages was lost. The reason for the reduced effect is not clear, although it is plausible that consumers give an element of 'expert' status to consumer advocacy groups when faced with conflicting information. Fox et al. (2002) suggest their findings may be applicable to novel technologies such as genetic modification.

### 2.2.2 Genetic modification

Genetic modification of foods remains a controversial issue among consumers. Much of the concern appears to relate to genetic manipulation that involves recombinant DNA or biotechnology techniques associated with genetic engineering. Genetic engineering of plants and animals is made possible by molecular biology techniques that enable the transfer of genes from one organism to another. In 2010, 22% of the seeds marketed and planted around the world were genetically engineered. The crops included those that resisted insects, disease, pesticides and extreme weather conditions, and/or had enhanced nutritional value compared to conventional breeds (Benessia and Barbiero, 2012). Neither the genetically engineered salmon nor the Enviropig, the first transgenic animals nearing commercialization, have yet made it to market (Lee and Leung, 2013). While numerous studies have shown genetically engineered plants to be safe, others have identified potential health risks and raised questions about experimental design and long-term effects (de Vendômois, 2010; Domingo and Giné Bordonaba, 2011).

Using a relatively simplistic approach, Brewer and Rojas (2008) found that 31.7% of consumers would not purchase genetically modified foods. In fact, 22.6% of consumers believed that genetically modified foods were not safe to eat under any circumstances. Furthermore, 39.3% would pay more for non-genetically modified foods. These findings do not provide much insight into the rationale for the responses. While there may be some concerns about the safety of genetically engineered foods and ingredients, consumers seem to consider other factors when considering the acceptance of food biotechnology (Kuzma and Besley, 2008).

Several studies have considered consumer perceptions of genetically modified foods in different countries (Mucci and Hough, 2004; Christoph et al., 2008; Costa-Font and Gil, 2009; to name a few). Research on this topic requires looking beyond food safety and asking questions that will enable the assessment of complex interactions among socio-psychological factors affecting the acceptance of genetically modified foods.
Variables may be related to benefits, risks/costs, uncertainty, trust and/or acceptability. According to Siegrist (2008), benefits and/or demonstrated experience (e.g. tasting) tended to increase the likelihood that consumers would accept genetically modified food. This is supported by de Liver et al. (2005) who determined the relative importance and independence of positive and negative thoughts (e.g. (un)useful), positive and negative feeling (e.g. pleasure/pain) and risk perception (e.g. risk/worry) and their influence on overall attitude towards the technology.

A ‘natural’ or ‘traditional’ product may taste better than the same product labeled as made with genetically modified ingredients. In fact, valuing ‘naturalness’ and ‘organic’ foods were important indicators of a negative perspective about new technologies (Siegrist, 2008). As correlations, however, one might wonder whether the natural or organic preference was established before a negative attitude to the technology.

Labeling of genetically modified foods is voluntary in the US and Canada and mandatory in Europe. According to Brewer and Rojas (2008), 78.4% of US consumers agreed that foods containing genetically modified components should state so on the labels. In contrast, Hoban (1998) indicated that three-quarters of American consumers supported existing labeling legislation that biotechnology products only need labeling if they have changed in a substantive way. Labeling provides the opportunity for choice and informed consent. Consumers may prefer to avoid genetically modified components for philosophical or any other reasons. Without a label statement, they would have to seek out and purchase products with a certification standard that indicates absence of genetically modified components. Reiterating a science-based risk assessment that claims a genetically modified food is safe, or dismissing consumer concerns, seems patronizing. Furthermore, it ignores the ethical principles relating to the individual, such as autonomy (Kuzma and Besley, 2008).

Siegrist (2008) identifies that trust is important: trust in the source of information about the technology, in the people delivering the message and in the industry. The environmental, economic and other risks of introducing a transgenic species into production may have been downplayed. Benessia and Barbiero (2012) refer to the myths of containment and enhanced yield. Furthermore, recent experiences with cross-pollinated plants have shown that genetically modified crops are not always contained, giving credence to non-food safety concerns (Biello, 2010). Consumers may have legitimate concerns about some risks about genetically modified foods.

2.2.3 Nanotechnology

As with any new technology, nanotechnology brings with it both benefits and risks. The technology is so new that there are very few studies on consumer knowledge about it or attitudes towards it. Although nanotechnologies can vary widely, they have certain characteristics in common. It is these characteristics upon which the US Environmental Protection Agency based its definition: ‘Nanotechnology is research and technology at the atomic, molecular or macro-molecular levels using a length of scale approximately 1 to 100 nanometers, in any direction; the creation and use of structures, devices and systems that have novel properties and functions because of their small size; and the ability to control and manipulate matter on an atomic scale.’ A study by Gaskell et al. (2005) concluded that ‘the US has a more supportive culture for the adoption and development of nanotechnology than Europe.’

In recent years, nanotechnology has been used in food and food packaging and it is claimed that the safety and quality of food will improve as a result. In a recent exploratory study that investigated the acceptance of nanotechnology in food, a ‘one-to-one deliberative discourse’ was conducted between consumers who were unfamiliar with the use of nanotechnology in food and a food scientist with expertise in nanotechnology. The food scientist presented each consumer with a series of hypothetical scenarios about the benefits and risks of applications of nanotechnology in food. In-depth interviews with the consumers were conducted before and after the scenarios in order to
determine their perceived influence on attitudinal change. Information presented in the scenarios seemed to have a positive impact on consumers’ attitudes toward the use of nanotechnology in food and the likelihood of consumers purchasing foods that used nanotechnology either during processing or packaging. There was greater acceptance of the technology when the consumers perceived that the benefits (to themselves or society) outweighed the risks (Greehy, 2011).

A review article on new food technologies presented a case study which included consumer attitudes towards nanotechnology (Rollin et al., 2011). The highlights of this report include the following: European and North American consumers were equally optimistic about the future of nanotechnology; Europeans were more concerned about its impact on the environment and less confident in regulation; benefits of the technology, fear of the unknown and the ability of regulators to ensure nanotechnology safety were the main risks perceived by consumers; and, demographically, women were substantially less optimistic and slightly less supportive of the technology than men. Interestingly, it was suggested that religion may influence consumer perceptions of the relative benefits and risks of nanotechnology.

2.2.4 Hormone use in food animals

The European Union has prohibited hormones as production aids since the early 1980s (European Commission, 2005). In contrast, Canada allows hormone use only in beef cattle, while the US permits hormone use for beef cattle as well as for milk production in dairy cattle. For context, hormones are naturally present in all mammals with varying levels depending on age, physiological status and pregnancy status (Waltner-Toews and McEwen, 1994; Raun and Preston, 2002). According to Brewer and Rojas (2008), nearly half the consumers in a US study were concerned about ‘hormone residues in poultry; meat or milk’, which measured as strong and very strong concerns (24.5% and 20.9%, respectively) on a 5-point Likert scale. This was an increase in concern from the previous study in which Brewer and Prestat (2002) found consumers strongly or very strongly concerned about hormone residues in meat (17.1% and 21.9%, respectively) and in milk (17.6% and 18.2%, respectively).

2.2.4.1 Beef production

The natural hormones used as production aids for beef animals include testosterone, estradiol-17β (estrogen) and progesterone; these are identical to those produced by humans. Synthetic hormones mimic the naturally occurring chemicals (Doyle, 2002). These hormones increase the weight gain and feed efficiency of steers and heifers raised for meat (Waltner-Toews and McEwen, 1994; Doyle, 2002). When natural hormones are used to treat animals, the levels in the animals’ systems remain within the normal range of untreated animals so no maximum residue limit is established (Doyle, 2000). Synthetic hormones are treated differently from natural hormones. They are considered contaminants at any level (Waltner-Toews and McEwen, 1994), and require safety evaluations to examine their toxicological effects on animals (Doyle, 2002).

Most exogenous hormones are in slow release form, implanted in the ears of beef animals (Waltner-Toews and McEwen, 1994; Doyle, 2002). The implants increase hormone levels in the animal tissues; however, the ears would have the highest amount of residue and are discarded at slaughter. According to Waltner-Toews and McEwen (1994), residues of the synthetic zeranol, which mimics estradiol, have been detected in beef liver up to 120 days after having been implanted; the withdrawal period is 65 days. Improper use of the hormones such as excessive (UKVPC, 2006) or incorrect implantation may increase exposure of humans to these chemicals, as would illegal use in non-beef animals such as veal (Waltner-Toews and McEwen, 1994). The European Union cited a number of veterinary drug studies that either support the claim that sex hormones for beef production are unsafe or demonstrate that the science is uncertain. In addition, illegal use of hormones can be a concern:
violative residues are occasionally found in animal products (Smith et al., 1997).

Despite the risk assessments that showed low risk and re-evaluation of data, the European Union’s Scientific Committee on Veterinary Measures Relating to Public Health (SCVPH, 2002) expressed concern in 1999 about what it considered a substantial body of research suggesting that estradiol, a natural hormone, is a carcinogen. In 2003 the European Parliament amended its directive that prohibited using hormones for growth promotion, and significantly reduced the circumstances under which estradiol is permitted for therapeutic use in food animals (European Commission, 2005). In contrast, the United Kingdom’s Veterinary Products Committee (UKVPC, 2006) indicated that there was more than enough evidence to show that estradiol poses no risk to humans unless the area at the implant is consumed. UKVPC confirmed that, despite some unknowns, the health risk from meat treated with growth-promoting hormones is low.

2.2.4.2 Milk production
Bovine somatotropin (BST) is a growth hormone in cattle that can be used to increase milk production in lactating dairy cows by 10–15% during treatment (Crooker et al., 1994). Recombinant DNA technology has made it practical to produce synthetic BST (rBST) commercially. The rBST molecule has essentially the same chemical structure and biological activity as BST (Crooker et al., 1994; IFST, 2004). Cows treated with rBST produce milk that is considered to have the same composition of nutrients and hormones as milk produced by untreated cows (FAO, 1993; Crooker et al., 1994). rBST is a large protein so is digested before its molecular components are absorbed in the gut (Crooker et al., 1994; Waltner-Toews and McEwen, 1994). The molecular structure of BST is different from human somatotropin, making it unable to bind on human receptor sites and rendering it inactive as a growth hormone (Crooker et al., 1994; IFST, 2004). Even if rBST were to be consumed by humans in milk or meat, it could not be absorbed or bound to receptor sites.

While BST and rBST levels do not increase in milk of treated cows, researchers have found a significant increase in the amount of insulin-like growth factor 1 (IGF-1). IGF-1 is normal and highly variable in milk (FAO, 1998). Bovine IGF-1 is identical to human IGF-1 and, unlike rBST, is not readily denatured at pasteurization temperatures (FAO, 1993). In its risk assessment, the Joint FAO/WHO Expert Committee on Food Additives (FAO, 1998) noted that human babies are exposed to equal or higher levels of IGF-1 in breast milk than is found in bovine milk from rBST-treated cows. The Expert Committee determined that the impact, probability and uncertainty related to a negative human health outcome from rBST and bovine-source IGF-1 are low. As a result, there can be no specified acceptable daily intake (ADI) and maximum residue level (MRL) for these compounds.

Some consumers expressed concern about the food risk associated with an expected increase in antimicrobial use due to increased mastitis in heavy producing cows (Kaiser et al., 1992). This has not been substantiated (FAO, 1998).

2.2.4.3 Benefit versus risks
The main benefit of the use of hormones is the increase in production efficiency. This is a benefit to producers, although consumers may benefit through product pricing (Kaiser et al., 1992). Is there a food risk worth taking for this potential benefit? Some countries identified non-food outcomes to consider (e.g., negative animal welfare risks) in the balancing of issue risk management. According to Brinckman (2000), the EU justification for banning rBST was finally associated with animal health and welfare concerns rather than a precaution related to food risk. The Government of Canada also cited animal health and welfare concerns in its decision not to permit the use of rBST.

Risk communication may help mitigate some of the concern. In a premarket survey, Kaiser et al. (1992) identified that consumers who had negative attitudes towards the use of rBST were more likely to want milk produced with it to be labeled. The researchers suggested that the
dairy industry should implement an educational strategy to counteract negative consumer attitudes toward rBST use in milk production. Kolodinsky (2008) identified that a negative attitude to genetic modification influenced consumer evaluation of milk labeled as rBST-free and organic.

### 2.2.5 Organic foods

Organic food is produced using environmentally sustainable methods that do not involve inputs such as chemical fertilizers, most pesticides, genetically modified seeds/feeds, hormones or antibiotics. Foods must not be processed using irradiation, not contain genetically modified organisms and not contain industrial solvents or chemical food additives (Paul and Rana, 2012). Individual philosophical perspectives inspire people to produce, purchase and/or consume organic products.

Who purchases organic food? An examination of demographic variables suggests that younger consumers generally have more positive attitudes towards organic food (Magnusson et al., 2001) but it is older and more highly educated consumers with higher household incomes who tend to purchase it more frequently (Paul and Rana, 2012; Roitner-Schobesberger et al., 2008; Sangkumchaliang and Huang, 2012). A factor which restricted the market share for organic vegetables in Thailand was the difficulty that consumers experienced in differentiating between ‘pesticide safe’ labels and organic produce labels (Roitner-Schobesberger et al., 2008).

The most commonly reported reason for the purchase of organic food is that it is healthier; consumers want to avoid the pesticides that are used in conventional food production because they perceive them to cause health problems in the short or long term. While organic fruit and vegetables should contain fewer pesticide residues than their conventionally grown counterparts, the difference has been reported to be insignificant (Magkow et al., 2006). Some leafy, root and tuber organic vegetables seem to contain lower levels of nitrate than conventional vegetables, but it is unclear whether nitrate in the diet is a threat to human health (Magkow et al., 2006). Consumers should therefore not equate the term organic with food safety.

A second motive that has been reported for purchasing organic food is that the taste is better. This motive has however been shown not to hold true for different categories of food. Concern for the environment has also been shown to influence consumers’ attitudes towards organic foods, but it is of less importance than perceptions of superior healthiness and taste. Other motives underlying purchase behavior include concern for food safety, concern for animal welfare, support for the local economy, appreciation of the ‘wholesomeness’ of organic food, reminiscence of the past and its current popularity (Hughner et al., 2007).

Consumer attitudes towards organic foods do not translate directly into purchase behavior. According to Andersen (2007), households that perceive organic foods as healthier than conventional foods are more likely to purchase organic food and are more willing to pay a premium price for it than other households. Factors that have been reported to interfere with the intention to purchase are the lack of availability of organic food, cosmetic defects, consumer skepticism about organic food labels, lack of knowledge due to insufficient marketing/promotion and, finally, general satisfaction with conventionally grown food (Hughner et al., 2007). While there are numerous references that identify reasons for the purchase or non-purchase of organic foods, very few address which members of a household actually consume organic food.

### 2.2.6 Deliberate and accidental contamination

With the food supply becoming increasingly global, it is essential that it be protected against contamination that is either deliberate or accidental. Deliberate contamination is usually for the purpose of economic gain, although there has been a US report of contamination for political gain (Homeland Security Newswire, 2009 in Zach et al., 2012). There has also been documentation
of interest in contamination of the food chain by terrorist groups abroad (Kennedy, 2009 in Zach et al., 2012) although, to date, such a terrorist attack has not occurred. Regardless of the underlying reasons for the contamination, the outcome can be serious or even fatal to consumers.

The range of practices designed to deliberately contaminate food includes adulteration, counterfeiting, comingling and substitution. Examples of deliberate contamination include ‘watering down or adding inert ingredients to products such as infant formula and drugs, relabeling products that have passed their expiration dates, relabeling to change country of origin (e.g. honey laundering; Berfield, 2013), and substituting cheaper species of fish for more expensive ones’ (US Government Accountability Office, 2009 in Zach et al., 2012, p. 154). Most recently, European consumers were shocked to learn that horse meat had been substituted for beef and other meats (Premanandh, 2013). Even organic products are not exempt from fraudulent claims. The USDA maintains a list of companies that have falsely claimed to be suppliers of certified organic products.

Import of foods and of raw materials used to produce processed foods presents a particular challenge. In the latter case, the opportunity for deliberate contamination is increased because of the potential for a single ingredient to contaminate multiple products and also because of the greater length of the food chain. The more complex the food chain, the greater the opportunity for contamination. Food safety concerns became a major issue in domestic food markets in China between the years 2003 and 2006 because of incidents involving food poisoning, discovery of dangerous dyes and additives to food products, fraudulent products and the sale of food that had passed its expiration date (Wang et al., 2008). In 2008, contamination of infant formula with melamine involved deliberate contamination that killed young children. While imports from China tend to be highlighted, those from more developed countries also occur. According to a recent ABC News report on counterfeit foods (ABC, 2013), 7% of the US food supply is estimated to be counterfeit. Products such as olive oil, spices, tea, pomegranate juice and lemon juice were highlighted, but in fact counterfeiters are interested only in financial gain, so all food products are potential targets. Governance in the form of anti-counterfeit measures by food manufacturers, ongoing diligence, training by trade associations and government initiatives and regulations all support the fight against counterfeit goods.

Accidental contamination of food does occur. This may occur in imported foods because members of the food chain (farmers through food processors) are unfamiliar with specific safe practices or with additives that are approved for use. For example, non-hygienic growing, packing and shipping of cantaloupes from Mexico led to the growth of Salmonella and ultimately to the ban on importation of cantaloupes by the US (Zach et al., 2012).

Protecting consumers from both deliberate and accidental contamination has been, and will continue to be, an ongoing challenge. Traditional food safety initiatives are no longer considered adequate to protect the food supply from deliberate attack. A variety of measures, spanning the entire food production cycle, are used. At the farm level, security cameras may be used to enhance the surveillance of entire facilities, including fields and parking facilities. At packing plants and processing facilities, HACCP programs can and should be carefully examined in order to identify and strengthen the most vulnerable points. During shipping, the opportunity for tampering and terrorism can be reduced by use of secure locks, security systems and seals. At the retail level, labels on food should provide accurate and adequate information to allow consumers to make informed choices about the food they purchase.

Hence, testing to ensure that the content of a package matches the information on the label has become a routine practice. It has been suggested that a description of issues of authenticity on products would help to increase consumer confidence in those products (Premanandh, 2013).

While consumers can be assured that food is well protected against both accidental and deliberate contamination, it must be understood that doing so
comes with a cost. All security enhancements must be balanced against the tight profit margins on food. Even with these safeguards, most consumers probably do not understand the crucial role of food safety regulations. In order to protect consumers, it is important to understand their attitudes towards food safety.

2.3 Consumer attitudes, knowledge and behavior

An attitude towards an issue is a relatively permanent and stable evaluative summary about it. Attitudes are important psychological constructs because they have been found to influence and predict many behaviors (Kraus, 1995).

2.3.1 Types of food safety issues

Consumer attitudes towards food safety can be differentiated based on the type of food safety issues of concern. Brewer et al. (1994) proposed that six factors dominated respondents’ attitudes towards the safety of their food: (1) chemical issues such as food additives and hormones in milk; (2) health issues such as cholesterol content; (3) spoilage issues; (4) regulatory issues, e.g. food inspection and labeling; (5) deceptive practices; and (6) ideal situations, such as time required for pesticide safety assessment.

Consumer attitudes and behavior towards food have been studied using approaches such as the Ajzen–Fishbein model of reasoned action and the health belief models. These models explain that individuals make rational decisions about behavior that affects their health when they are aware of associated health problems, have some knowledge about these problems and make a judgment about the level of risk involved in not changing their behavior. Thus, the willingness to change behavior is determined by perceptions and beliefs. In order to change, people must perceive that their current behavior is detrimental to their health and that taking action is likely to reduce the risk. Perceptions and beliefs are shaped by knowledge, which is acquired from exposure to information sources along with personal efforts to obtain information.

Considerable information about consumer knowledge and self-reported food safety behavior is available, but observational studies suggest that large numbers of consumers follow unsafe food handling practices. Redmond and Griffith (2003) believe that observational studies provide a more realistic indication of food safety behavior in domestic food preparation because in their work, knowledge, attitudes and self-reported practices did not correspond to observed behavior.

Woodburn and Raab (1997) showed that respondents were not good at identifying either the foodborne illness or the groups of people particularly at risk for food poisoning. They also found that 40% of the 100 Oregon food preparers either believed that contaminated foods could not be made safe to eat or they did not know how to do so. After observing 108 consumers during all stages of the purchase, preparation, cooking and storage of one of four recipes, Worsfold and Griffith (1997) saw multiple examples of poor food handling practices leading to great potential for cross-contamination and subsequent food poisoning. On the other hand, a study found that food safety was rated as significantly more important when main meal planners were food shopping if they had one or more household members belonging to higher risk groups (Woodburn and Raab, 1997).

Awareness, knowledge and judgment can also be affected by habits and perceptions that result from social, cultural and economic influences. These may develop at an early age and become deeply ingrained. This can sometimes be due to stereotype behavior, where attitudes are developed without direct experience with the food in question (Cardello et al., 1996). Lifestyle changes have also been shown to be influential in consumers’ attitudes towards the safety of food handling. In April 1996, the American Meat Institute commissioned a study of 1000 adults in the US and concluded that lifestyle changes had had an impact on food behavior. These include an increasing number of women in the workforce, limited commitment to food preparation and a greater number
of single heads of households. Consumers appeared to be more interested in convenience and saving time than in proper food handling and preparation (American Meat Institute, 1996; Collins, 1997).

According to economic theory, the demand for food safety is determined by consumers’ willingness to pay for additional safety, and it is assumed that they are willing to pay less for each successive unit of safety (i.e., increasing marginal costs but diminishing marginal benefits). The supply of safety is determined by the cost of producing safety by profit-seeking firms. The market for food safety will therefore be in equilibrium when the price that consumers are willing to pay for increases in safety is equal to the price at which suppliers are able to produce the increases. At such equilibrium, the level of safety supplied by the market will reflect a level of risk which is non-zero but acceptable. Extrapolating from this, it is suggested that consumer demand for food safety is increased when the gross production of a country (gross domestic product) is increased, since the average consumer is equipped with higher purchasing power (Tangermann, 1986). Familiarity with food safety hazards is likely to reduce the effectiveness of hazard warnings (Breakwell, 2000). If the consequences of a health hazard are more immediate, it is easier to visualize the risk; this, in turn, elevates the sense of danger.

2.3.2 Knowledge versus behavior

Raab and Woodburn (1997) point out that there is a disparity between food safety knowledge and self-reported practices. Knowledge, attitudes, and behavior toward food safety have been shown to differ with demographic and socioeconomic factors. A large sample of senior undergraduate students in Greece completed a survey about food safety knowledge and practices (Lazou, 2012). Respondents answered less than 40% of questions about knowledge and behavior correctly. They were generally knowledgeable about the effects of freezing on bacteria and followed best practices for hand washing and prevention of cross-contamination. Knowledge of food safety was similar for males and females, but there was a marked difference between the two genders when it came to food handling behavior, for which males scored considerably lower.

In a study of the knowledge and behavior of hamburger meat of 1439 consumers in Texas, McIntosh et al. (1994) concluded that while better-educated people tended to choose health and safety as their reasons for cooking preference, these respondents were more likely to prefer their hamburgers to be less well cooked. Thus, the reasons for cooking preferences may not be influenced by either knowledge or mass media exposure. Furthermore, many individuals may not associate what they know about the risks of improperly cooked hamburger with their own practices.

In a telephone survey of 100 Oregon food preparers, Woodburn and Raab (1997) found that, even with a high awareness of foodborne illness, 20% of respondents reported unsafe practices in their food preparation. This is despite the fact that 56% of the respondents knew that they could thoroughly cook food contaminated with Salmonella to make it safe to consume and 59% knew this for E. coli.

The disparity between food safety knowledge and food handling practices of consumers can be attributed partly to optimistic bias, where people believe that they are less at risk from a hazard than other people (Miles et al., 1999). Optimistic bias may be caused by the fact that most members of the public are rarely given personalized information about their vulnerability to a hazard; they get information about risk to the population in general and infer their own risk status. This may result in a noticeable discrepancy between people’s perceived personal risk and their actual risk status (Frewer et al., 1994).

Optimistic bias has been to blame for food poisoning from food prepared in the home and food prepared by others. Raab and Woodburn (1997) found that about one-quarter of respondents believed that food eaten at home had a lower risk of causing food poisoning than food eaten out. Frewer et al. (1994) also found that respondents considered that they had substantial control
over the risks; they perceived low personal risk and high knowledge about food poisoning in the home. Optimistic bias is important, in that it may hinder initiatives designed to promote risk-reducing behavior. People may ignore risk communications, assuming that these messages are aimed at more vulnerable individuals, or that they are in control of the potential hazards and know enough to deal with them effectively.

2.3.3 Influence of consumer demographics

Available literature has indicated that, overall, consumer attitudes towards food safety are influenced by demographic and socio-economic factors such as gender, age, educational level and economic status. A study of adults from the US Food and Drug Administration's 2006 Food Safety Survey (Anderson et al., 2011) showed that adults 60 years of age and older were more likely to follow recommended food safety practices than those younger than 60 years. Among adults 60 years of age and older, there was a greater awareness of food safety risk among women, those with less education and non-white individuals. Another US study demonstrated that the food safety perceptions of elderly consumers who participated in congregate meal and home-delivered meal programs varied by geographic location, age, marital status and household composition; these demographic variables as well as gender, race and education influenced participants' self-reported food safety behaviors. Interestingly, there were significant differences in self-reported emergency food preparedness by race and level of education (Roseman, 2007).

Age, gender and level of education have been shown to affect food safety perceptions of ethnic restaurants. In a study of consumer food safety perceptions of Asian and Mexican restaurants in California and Florida, participants who were older, female and who had lower levels of education were most concerned about food safety. The majority of participants in this study reported that they had not suffered from foodborne illness, yet that they had experienced its classic signs (nausea, diarrhea and vomiting) (Lee et al., 2012).

Pregnant women are one of the most vulnerable groups of consumers to foodborne diseases (McCabe-Sellers and Beattie, 2004), although there are few studies related to food safety attitudes, knowledge and behavior within this group. A study of 491 Slovenian women (291 pregnant and 200 non-pregnant) showed that all had a high level of awareness of food safety issues; this awareness varied significantly with the town of residence and age of respondent. Food safety practices differed between the two groups; for example, pregnant women more frequently thawed food at room temperature but paid more attention to 'best before' dates than did their non-pregnant counterparts (Jevšnik et al., 2008).

The American multi-state survey conducted by Altekruse et al. (1999) reported that men were more likely to report risky practices than women. The survey results also indicated that the prevalence of most risky behaviors increased with increasing socio-economic status.

Burger (1998) interviewed 197 men and 94 women from a coastal population in New Jersey. He found that there were significant gender differences in the perceptions of the safety of fish, ducks and deer. Women generally believed that it was more risky to eat these foods than men. However, it was generally thought that it was safer to eat fish that consumers caught themselves or bought in a fish store than fish purchased from a supermarket.

2.3.4 Knowledge and behavior

In recent years, considerable resources have been devoted to increasing the level of food safety knowledge among consumers. For a food safety program to be effective, there must be a thorough understanding of the channels of communication most used by the target audience. Common media used in the past included television, radio, newspapers and magazines and publically distributed leaflets; the use of television as a source of information about food safety was shown to lead to a superior knowledge of foodborne disease whereas both television and print media were most effective in generating a willingness to change behavior.
(McIntosh et al., 1994). With the current popularity of social media, the optimal format for delivering food safety education may have changed. A single medium is not ideal; food safety education for pregnant women may be delivered effectively using social media, but what about the elderly who may depend on others for their food preparation? Men care less about food safety than women do (Aakkula et al., 2005), so how are they best reached? The use of smartphone technology (with software such as the ‘4 Day Throw Away’ application) is an innovative way to deliver food safety information to young families who might have questions about food safety (Albrecht et al., 2012). Clearly, the choice of medium and the content of the message are both critical considerations (McCarthy and Brennan, 2009).

There is no doubt that consumers could benefit from food safety education, especially education about food-handling behaviors that are most likely to cause foodborne illness. The emphasis of such food safety education should be directly correlated to the relative frequency of behaviors that cause foodborne illnesses, i.e. more emphasis should be placed on behaviors that can be shown to cause more foodborne illness (Medeiros et al., 2001). In the US, personal hygiene (especially hand-washing) and adequate cooking/avoiding cross-contamination should be given the greatest emphasis since these behaviors are reported to be associated with 10 million and 3.4 million cases of foodborne illness per year, respectively. Safe storage temperatures and avoiding food from unsafe sources should be given relatively less emphasis since these behaviors have been associated with comparatively fewer foodborne illnesses (0.5 million and 10,000 cases per year in the US, respectively) (Medeiros et al., 2001). Over time, the emphasis in food safety education may change with the relative frequency of foodborne illnesses and consumer behaviors.

Consumer education messages should include the ubiquity of microorganisms, a comprehensive description of foodborne illnesses and prevention strategies. Product labels should contain food-handling information and warnings for special populations; information about foods processed by newer safety-enhancing technologies should be made more widely available. Knowledge of the consequences of unsafe practices can enhance motivation and adherence to safety guidelines. These are the responsibilities that should be shared by the health community, food industry, regulators and the media (Bruhn, 1997).

Food safety education and training should emphasize risk management and should target high-risk groups, as well as those preparing food for people in these groups. It must be updated regularly, and be based on emerging food safety trends if it is to remain effective in the long term.

### 2.4 Conclusion and outlook

Consumers' attitudes toward food safety, food handling practices and new technologies are of interest to a wide range of stakeholders such as food producers, processors and retailers and public health professionals. These attitudes are complex, and are formed by the interaction of factors such as demographics, philosophical perspectives and social, cultural and economic conditions.

Numerous technologies have been discussed in this chapter. Not surprisingly, consumers are likely to perceive personal and/or societal risks with each of these technologies. Those perceived risks vary with the nature of the technology; concerns related to technologies considered ‘bioactive’ may be escalated for ethical reasons and/or because of their unpredictable nature (Frewer et al., 2011).

Furthermore, the balance of risks and benefits is important to consider. For example, do industry and consumers share the benefits equally or are the benefits disproportionately in favor of one stakeholder over the other? Do consumers have control over their exposure to a technology? In a review by Frewer et al. (2011), the least-controversial technologies were those that were limited in terms of their bioactive nature.

Finally, individual differences among consumers will have a profound influence on their acceptance of new food technologies and are likely to change over time. The challenge is to understand how to
best assist consumers in balancing the risks and benefits relative to their own frames of reference. There is a need to learn more about consumer attitudes and behaviors, create awareness of the benefits and risks of new technologies, promote trust in credible information sources and make available relevant food safety information.

References


