ABSTRACT

The current study assessed the perceived value of food traceability in modern society by young consumers. After experiencing numerous recalls and food safety-related incidences, consumers are increasingly aware of the tools available to mitigate risks. Food traceability has been associated with food safety procedures for many years, but recent high-profile cases of food fraud around the world have given traceability a different strategic purpose. Focusing solely on dairy products, our survey results offer a glimpse of consumer perceptions of traceability as a means to preserve food integrity and authenticity. This study explored the various influences that market-oriented traceability has had on dairy consumers. For example, results show that if the dairy sector could guarantee that their product is in fact organic, 53.8% of respondents who often purchase organic milk would consider always purchasing traceable organic milk. This research produced a quantitative set of information related to the perceived value of food traceability, which could be useful for the creation and development of improved guidelines and better education for consumers. We discuss limitations and suggest areas for new research.

Key words: traceability, dairy foods, value

INTRODUCTION

The simplicity of distribution systems during the preindustrial era suggests that tracing the origins and handling of food products that people consumed was less complicated than it is today. Most food products were locally grown, processed, and retailed, and wholesaling was not as common. The dichotomy between the supply of food and the demands of consumers has only increased due to increasingly complex distribution systems caused by population growth. As a result, consumers today are compelled to trust and rely upon system efficiencies for the assurance that the food products they consume are safe and wholesome (Underdahl and Slater, 2014). Some observers have argued that food safety is at greater risk because of the increasing globalization of food systems (Charlebois et al., 2014). Due to rapid transport and mobility of raw food ingredients and products across the globe, hazards can spread more quickly than in the past; therefore, modern food safety-related incidences can potentially affect many millions of consumers. The commoditization of data and the globalization of information have also had a significant influence on risk perception and consumer preferences (Hoorfar et al., 2011). The growing complexity of food supply chains, the heterogeneity in food safety regulations across countries, and lack of uniform requirements from one commodity to another are some factors that explain why the business case for greater efficiency in food traceability systems has increased in recent years.

The aim of this study was to explore consumer knowledge, attitudes, and practices relating to food traceability with a specific focus on dairy products. It is important to understand fully how food traceability can serve strategic purposes beyond food safety. Our findings provide a factual basis for further investigations and a review of current food policies on traceability.

The Emergence of Food Traceability

Several definitions of traceability are currently in circulation, including definitions used in international standards and references [i.e., ISO 8402 (ISO, 1994), ISO 9000 (ISO, 2000), ISO 22005 (ISO, 2007), and Codex Alimentarius (FAO/WHO, 1997)], in legislations in some regions (e.g., the European Union’s General Food Law; Regulation 178/2002), as well as the commonly cited standalone definition used in scientific articles (i.e., traceability as defined by Moe, 1998; Olsen and Borit, 2013; Karlsen et al., 2013). Traceability is commonly defined as the ability to trace products back and forth throughout the supply chain, from farm or point of production to the end user. According to the Codex Alimentarius Commission “The traceability/product
tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system” (Codex Alimentarius, 2006).

Opara (2003) believes that traceability should include the following 6 main elements: product traceability (physical location of products); process traceability (any type of activity, and the sequence of the activities applied on the product); genetic traceability (genetic formation of the product); input traceability; disease and pest traceability (tracing the epidemiology of pests and biohazards); and measurement traceability (relates individual measurements results to accepted reference standards) (Karlsen et al., 2013). Traceability can be deployed as a tool to answer 6 general questions: “who (i.e., product), what (i.e., product’s information), when (i.e., time), where (i.e., location), how (i.e., production practices) and why (i.e., cause/reasons) that are related to food safety, quality and integrity” (Aung and Chang, 2014).

An increase in trade among nations has led to increased focus on food traceability in food products (Olsen and Borit, 2013). The primary reason for this increased focus can be attributed to the numerous tragic and costly food scandals that have received worldwide attention, such as mad cow disease, the Hudson Foods recall in the United States in 1997 (Olsen and Borit, 2013), and the contamination of chicken feed with dioxin in Belgium in 1999 (Bernardet al., 2002). The outcome of these scandals was the incorporation of traceability into food regulations (Karlsen et al., 2013). The occurrence of bovine spongiform encephalopathy (BSE, or mad cow disease) in cattle around the world in the early- and mid-1990s led to mandatory livestock identification and traceability programs in many countries, which resulted in improved confidence with global trading of live animal and related meat products (Charlebois and Camp, 2007). Traces of horsemeat discovered in beef products in 2013 throughout Europe have compelled regulators and consumers alike to question current practices when tracing and tracking ingredients and food products.

The global concern for food safety, authenticity, and quality, as well as the importance of traceability, has resulted in the development of regulations, new international standards, and industry guidelines (Petersen, 2004). In Europe, Directive 178/2002 requires mandatory traceability for all food and feed products sold within European Union (EU) countries, which enforces strict regulations on labeling of food products as well as on animal traceability through animal identification and movement program. Every member state of the EU is required to institute and maintain a cattle identification and registration system for individual animals using individual ear tags, computerized databases, animal passports that show the history of the animal, and individual registers kept on each holding (Europa, 2011). In 2011, as a part of the Food Safety Modernization Act (FSMA), the USDA introduced an Animal Disease Traceability requirement on livestock being transported across state boundaries. The regulation was finalized in late 2012, requiring that livestock moved interstate needed to be officially identified and accompanied by an interstate certificate of veterinary inspection or other documentation (USDA Global Agricultural Information Network, 2013). Other organizations such as the Codex Alimentarius Commission, established by the Food and Animal Organization of the United Nations (FAO), the World Health Organization (WHO) and the International Organization for Standardization (ISO) have developed international standards and guidelines for food traceability (Petersen, 2004).

The discovery of BSE in Canadian cattle in 2003 led to a border closure for export, and resulted in a $5.3 billion loss for Canadian beef producers by the end of 2004 (Statistics Canada, 2006). As a result, livestock identification is now a part of animal traceability enforcement in Canada. It requires that cattle, sheep, and bison, and soon caprine to be registered and tagged with identification numbers from birth to slaughter (CFIA, 2014a). Livestock traceability systems are based upon 3 basic elements: animal identification, premises identification, and animal movement. The policy is regulated by Health of Animals Regulations and enforced by the Canadian Food Inspection Agency (CFIA, 2014a). In the latest news release from CFIA, pig farmers and other pig industry custodians are obliged to keep records and report all movements of pigs from birth to import, slaughter, or export. The regulations detail how farmed pigs and farmed wild boars are to be identified. Effective July 1, 2015, the regulations will be extended to include farmed wild boars (CFIA, 2014b). However, for other food commodities in Canada, there are no specific traceability regulations. Traceability of processed food products is verified through proper packaging and labeling, as per the Consumer Packaging and Labeling Act, the Act and Regulations for a food commodity, as well by the Food Safety Enhancement Program (FSEP) of the Canadian Food Inspection Agency for meat products. Federally regulated processing plants must establish hazard analysis and critical control point (HACCP) plans and prerequisite programs and must be able to demonstrate product recall and traceability (F 1.1.1) and product coding and labeling (F 1.1.2) (CFIA, 2013).

Legislations and regulations are not the only driving force behind the increased interest in food traceability.
Other factors, such as food safety and quality, food sustainability, reducing costs, obtaining certifications, competitive advantages, chain communication, and production optimization have also been identified (Olson, 2009; Karlsen et al., 2013; Underdahl and Slater, 2014).

Increased consumer demand for healthy, safe, and wholesome food products has compelled the food industry to become more consumer focused. Modern consumers' choices reflect how important production practices have become in the marketplace. Organics, local foods, and halal and kosher products all require evidence to support market-level claims. In addition, due to food trade globalization, food integrity issues include safety as well as origin fraud and quality concerns. However, labeling of food products alone cannot assure the safety, quality, and integrity of food products to encourage consumer confidence; therefore, traceability is essential (Aung and Chang, 2014; Underdahl and Slater, 2014). To build customer confidence, food producers must manage their food chain by following regulations or standards, obtaining certifications, and providing a transparent food traceability system (Hong et al., 2011).

In general, traceability can be used as a tool to achieve the 3 main objectives: managing risks related to food safety and animal health issues; guaranteeing product authenticity and providing credible information to customers; and improving quality and processes of products by identifying noncompliances (Germain, 2003).

**Challenges in Food Traceability**

Along with the many benefits of traceability systems, there are also many problems and limitations. A key limitation, mainly for small-scale producers, is the cost associated with implementing a traceability system. One of the biggest challenges in supply chain traceability is the exchange of information in a standardized format between various links in the chain. This information needs to be exchanged in an effective manner. Robust mechanisms are needed to facilitate the collection and authentication of all information to enable it to be updated and shared throughout the chain. Paper is still a more affordable option for traceability, particularly for smaller operations, although it limits the ability to record data accurately, store it, and query it to identify and trace products. Digital databases for traceability are seen as more expensive to implement, operate, and maintain, requiring hardware and software, skilled human resources, training, and certification (Karippacheril et al., 2011)

Specific limitations are placed on different products in the food industry. For example, bulk produce is generally found more challenging to trace compared with fresh produce. Products such as grain, coffee, olive oil, rice, and milk from multiple farms may be combined in silos or storage tanks, making it more difficult to trace the product back to its various sources (IFT, 2009). In addition, many industries use ingredients in different forms: liquids (e.g., milk, oils), powders (e.g., cocoa, powdered milk, flour), crystals (e.g., salt, sugar), or grains that are usually stored in silos that are rarely fully emptied; therefore, different lots are simultaneously in the same storage or mixing area. For distinct batch identity, it has been stressed that cleaning between batches is of primary importance; however, the proposed cleaning procedures are costly for the industry (Cocucci et al., 2002). Specifically, in the case of milk production, where continuous production systems and minimal interruptions are required, stopping operations to clean and separate distinct batches is very costly and difficult (Dennis and Meredith, 2000; Skoglund and Dejmek, 2007). Overall, the presence of a variety of portions of product deriving from the partial mixing of 2 subsequent lots limits the traceability of the product.

Another problem or limitation associated with the tracing of bulk products is the limited markers or identifiers that can be applied to directly identify the lot or batch without compromising the integrity and quality of the food product in any way. Radio frequency identification (RFID)-based traceability systems require the development of a technology that can safely remove the tracing devices from the final product. Recently, some solutions, such as using specialized ink-jet printers with food-grade ink to print bar codes or data matrix (DM) code symbols on the particles, have been suggested; however, they are not commonly used in the food industry (Dabbene et al., 2014).

In general, paper systems are still widely used for traceability procedures in small and even large food industries. However, many different food sectors have incorporated electronic traceability in their systems. Active RFID tags are the most cutting-edge technology for supply chain integrity and traceability. These tags can contain specific sensors (e.g., temperature, humidity) and can transmit the measured data as well as the product’s identification code. In this way, the traceability system can automatically capture a range of information concerning product identity, properties, and data (e.g., temperature history), thus providing the managing system with a complete description of the current state of the product (Dabbene et al., 2014). However, RFID systems are still considered too costly (Aarnisalo et al., 2007), and it remains difficult to
achieve 100% readability of RFID tags through metal, glass, or liquid (Petersen, 2004).

Techniques based on such as barcoding are also very effective in certifying both the origin and quality of food products (i.e., raw materials), as well as detecting any adulterations that may occur in the industrial food chain. DNA barcoding can be particularly efficient where an international platform repository “barcode of life database” (BOLD) is available. Also, products such as seeds, fruits, and different plant and animal parts are transformed in food with a definite shape, tastes and smell through physical (i.e., heating, boiling, UV radiation) or chemical (i.e., addition of food preservatives, artificial sweeteners) treatments, which could alter DNA structure (Galimberti et al., 2013). These techniques are very expensive to apply in routine tests, but they could be a trusted tool with which to verify suspected fraud (Dalvit et al., 2007).

Traceability in food supply chains not only improves issues of consumer safety, and consequently product recall, it may also reduce the problem of fraud and counterfeiting. In the food sector, fraud can result in reputation and economic losses as well as reduced consumer confidence. Traceability tools can be used to prevent or eliminate illegal, unreported, and unregulated products through their ability to trace the history, process, and location of a product by means of recorded identification using technologies for product authentication, which are usually paired to tracking and tracing methods through the supply chain. Examples of tracking and tracing methods are encrypted tags (authentication can be by cryptographic algorithms) or machine-readable devices such as barcodes, QR or data matrix codes, and RFID systems. These methods not only allow for an increase in the number of checks and the ability to share electronic data, but their track-and-trace anticounterfeift systems can also be applied simultaneously (Dabbene et al., 2014).

Over the years, customer demand for information regarding food products they consume has grown, and it is one of the most competitive advantages of food industry marketing. This growing consumer demand affects higher requirements for well-structured traceability systems; therefore, traceability must emerge as a new index of quality and as a basis for trade. With increased access to electronic devices, consumers have the ability to check the labeling and the product history by reading the barcodes or RFID tags using their mobile phones. In fact, smartphones could be the future handheld device for traceability due to their portability and mobility. In this way, they act as sensors and RFID readers, allowing consumers to obtain detailed information on the products they consume. Web-based traceability can permit access to information on the quality and safety status of products for both consumers and producers. This will not only deliver more information to consumers, but can aid in faster recalls when quality and safety standards are breached (Aung and Chang, 2014).

In general, the primary consequences of a recall, besides the economic loss for the company, is the decrease in consumer confidence, where a negative brand image can remain in the subconscious of consumers for a potentially long period (Kumar and Schiefer, 2009). The performance of a traceability system can therefore be directly associated with its ability to hold down the amount and cost of the product to be recalled.

**Food Traceability in the Dairy Industry**

World milk production in 2013 was approximately 780 million tonnes, similar to production in recent years (722 and 765 million tonnes in 2011 and 2012, respectively). New Zealand and the EU were the 2 principal exporters in 2013, whereas Asia remained the main market for dairy products, accounting for some 55% of world imports, followed by Africa, with 15% (FAO, 2013). In 2013, the total dairy exports and imports of Canada were 88,295.4 and 173,241.6 t, respectively. As of March 2014, the total number of dairy farms with milk shipments in Canada was 12,219 (Statistics Canada, 2014).

Product traceability is the industry support for assuring the quality of products, and the dairy industry is no exception. Milk and dairy products are rich in nutrients, providing an ideal growth environment for many microorganisms, such as spoilage organisms in milk. In addition, milk can be a significant source of foodborne pathogens, the presence of which is determined by the health of the dairy herd, quality of the raw milk, milking and prestorage conditions, available storage facilities and technologies, and the general hygiene of the animals, environment, and workers, as well as external parameters such as the addition of water (de las Morenas et al., 2014). Milk and dairy products can also contain chemical hazards and contaminants, mainly introduced through the environment, animal feedstuffs, animal husbandry, and poor industry practices (FAO, 2013).

Minimizing health risks from milk and dairy products requires a continuous system of preventive measures, starting with animal feed suppliers, through farmers.
and on-farm controls (including the prudent use of veterinary drugs), to milk processors and the application of good hygiene practices and food-safety management systems throughout the chain. In general, the main risks to human health associated with milk and dairy products fall into 3 main categories: biological (i.e., pathogenic bacteria, toxigenic molds/fungi, parasites, viruses); chemical (i.e., naturally occurring toxins, direct and indirect food additives, pesticide residues, veterinary drug residues, heavy metals, environmental contaminants, chemical contaminants from packaging material and allergen), and physical (i.e., metal fragments, bone fragments, glass pieces, insect parts/fragments, jewelry, stones, and hair).

In general, studies show that outbreaks of foodborne illnesses attributed to milk and dairy products are mainly due to pathogens (e.g., Salmonella spp., Campylobacter, norovirus, Staphylococcus aureus, Escherichia coli, Listeria) rather than chemical contaminants (FAO, 2013). A study in the United States showed that Listeria in dairy products is the fifth most costly pathogen-food combination in terms of cost of illness and loss of quality-adjusted life years, following Campylobacter in poultry, Toxoplasma in pork, Listeria in deli meats, and Salmonella in poultry (Batz et al., 2012). In the United Kingdom, where milk is commonly pasteurized, it is estimated that less than 2% of all foodborne diseases are attributable to milk (Casemore, 2004). In February and March 2013, several European countries, including Romania, Serbia, and Croatia, reported nationwide contamination of milk for human consumption (and possibly of derivative products) with aflatoxins. Incidents of recall have been shown in both dairy products and in foods containing dairy products as an ingredient. The recall of contaminated milk of Maleny Dairies in Australia was caused by E. coli; the recall of whey protein concentrate of New Zealand’s Fonterra (the world’s fourth largest producer of dairy products) was due to a potentially fatal botulism bacteria found in some batches; and Roos Foods cheese products were contaminated with Listeria in March 2014 in the United States.

Many recalls and public warnings concern food products that contain undeclared milk as an ingredient or food products that have been mistakenly mixed with milk. One recent example involved orange juice recalls by the US Food and Drug Administration (2014), in which milk was mixed with orange juice due to a manufacturing error. Another example was the UK food recall of mixed seed bars that were contaminated with milk (UK Foods Standards, 2013).

In 2013, the Canadian Food Inspection Agency (CFIA) issued 52 public recalls and allergy alerts related to food products containing dairy products as ingredients (44 class-I cases and 8 class-I cases, where class I is a situation in which there is a reasonable probability that the use of, or exposure to, a violative product will cause serious adverse health consequences or death; and class II is a situation in which the use of, or exposure to, a violative product may cause temporary adverse health consequences or where the probability of serious adverse health consequences is remote). The recalls and alerts originated in products such as chocolate bars, protein bars, marshmallows, cookies, cakes, croissants, pastas, potato chips, cabbage rolls, perogies, and stuffing mix; all were due to undeclared milk or dairy ingredients in the products. Individuals with an allergy to milk were at risk by consuming the recalled products; as a result, the CFIA is now required to notify the public through updated food recall warnings (CFIA, 2014c).

As demonstrated by all of these cases, traceability of the recalled product throughout the food supply chain is essential to make product integrity for consumers more apparent. The possibility of transporting samples over long distances while ensuring quality requires efficient traceability techniques. There are many benefits from applying efficient traceability systems in the dairy industry. For example, dairy farmers benefit from improved reliability in the preservation of sample quality, as the traceability methods would help avoid the possibility of their high-quality supply becoming affected by the lower quality supply of other farmers. Personnel at the laboratory will be able to identify any problem and allocate responsibility to a specific person. Finally, customers will benefit from a higher quality product (de las Morenas et. al., 2014).

The most common way to identify samples is by using codes associated with farms. However, it would be desirable to extend the tracking with information relating to when the sample was taken and by whom. Food fraud cases have also affected the dairy sector. One of the primary fraud cases in the dairy sector was the 2008 discovery of melamine found in Chinese milk. Melamine is a chemical that is mainly used to produce plastics; however, it is rich in nitrogen and was therefore added to compensate for the low protein levels of watered-down milk (Qiao et al., 2010). Soon after the discovery, the Chinese government announced a recall of infant milk powder that contained melamine. A wide range of milk and products containing milk, including liquid milk, ice cream, and yogurt, was found to be contaminated (Xiu and Klein, 2010). The effect of the contamination was even more severe because the contaminated milk products had been exported from China to many countries, leading to public health concerns in importing countries. In addition to its serious effect on health, other consequences of the recall included finan-
cial losses; a large recall of food products at the interna-
tional level; pressure on importing countries to control
imports; disposal and dumping of large quantities of
contaminated milk; and the increased need for consum-
ers to identify alternative sources of safe milk for their
families (Qiao et al., 2010; Zhao et al., 2013). Although
government and industry both took immediate action
to improve the safety of dairy products, isolated reports
of melamine in milk continue. In February 2010, vari-
ous media sources reported that several old batches of
contaminated milk powder that were not destroyed, as
ordered by Chinese authorities, may have been avail-
able for sale after the recall (Le and Hornby, 2010).

Some challenges exist in developing authentication
methods; one of the main problems is the installation
of a marker (or markers) that can characterize the food
product, its ingredients, the adulterants used, or its
processing, production or geographic origin. Therefore,
the marker has to be specific, must have a limited
natural variation, and can be measured if necessary
(Primrose et al., 2010).

The most common method of adulterating milk
worldwide is the addition of large or small volumes of
water, although current industries, milk collection sta-
tions, public laboratories, and even some dairy farms
are equipped with a cryoscope or other instrument to
determine the presence and amount of water added.
Nuclear magnetic resonance and infrared spectroscopy,
mass spectrometry, capillary electrophoresis, ELISA,
and PCR have been successfully used to evaluate and
distinguish mixtures of cow, goat, buffalo, and camel
milks (Down, 2013). In the dairy industry, heat-treat-
ment indicators are not only useful for the heat clas-
sification of several milk products, but are also helpful
in discovering the occurrence of fraud. For example,
the ratio between the levels of furosine and lactulose can
help detect whether reconstituted milk powder or high-
temperature treated milk has been added to pasteurized
or UHT milk. The unnatural amino acid lysinoalanine
is an indicator that caseinates have been used in cheese
making, and the presence of the advanced Maillard
compound galactosyl-β-pyranone identifies heated
UHT milk (Resmini et al., 2003). Other markers, such
as use of lectin chips, may be able to determine if cow
milk has been added to buffalo milk or buffalo cheese
(Primrose et al., 2010).

Organic farming claims to have the potential to
provide benefits such as environmental protection,
conservation of nonrenewable resources, and improved
food quality; however, there are risks associated with
organic production that lead dairy farmers to ques-
tion its efficacy. A study showed that the gross margin
per cow is significantly higher in organic farming, and
therefore the milk yield per cow poses a significantly
higher risk in organic farming (Berentsen et al., 2012).
Due to high prices and the limited available natural
resources, procedures for authenticating organic milk
are also of high interest. The risk of conventional milk
fraudulently labeled as organic can be countered with
adequate controls to protect consumers and secure fair
trade. A starting point for potential procedures is the
milk composition, which can vary greatly depending on
differences in the diets of cows (Molkentin, 2013).

Organic food and beverage sales in Canada were app-
proximately Can$2.6 billion in 2010, compared with
Can$1 billion in 2006, with an annual growth rate of
20% over the past few years. Dairy makes up 11% of all
organic sales in Canada. In the 2011–2012 dairy year,
218 farms produced 1.19% of total Canadian dairy
production. The main provinces producing certified
organic milk are Quebec, Ontario, Alberta, and British
Columbia. On average, consumers are willing to pay 15
to 20% more for organic products, which is equal to the
premium paid by processors for raw organic milk (Ca-
nadian Dairy Information Centre, 2013). Several stud-
ies have attempted to characterize consumers of organic
products, often with conflicting results. Studies have
had difficulty determining which groups are more likely
to purchase organic goods, and the characteristics of
organic consumers have been found to change over time
(Dimitri and Venezia, 2007). A recent article studying
the characteristics of consumers of organic fluid milk
products showed that perceived taste of organic milk,
concern for the risk of consuming conventional milk,
being a primary shopper, and the quantity of milk con-
sumed are the major factors that separate experiment
participants into groups with high and low willingness
to purchase organic milk (Liu et al., 2013).

Consumer behavior and preferences in assessing the
priorities of food safety risks of milk and dairy prod-
ucts are important factors that must be considered. For
example, acceptance of raw milk is slowly increasing
(Hegarty et al., 2002). Some consumers prefer to buy
raw milk, because they believe that it is purer and
more natural than industrialized milk (e.g., pasteur-
ized or UHT); some prefer raw milk because of a taste
preference or the belief that it has special nutritional
benefits or medical properties; and some because of the
desire to consume local products. Some consumers are
suspicious of government regulation of food and believe
that pasteurization masks contamination; others argue
that access to raw food should be a matter of personal
choice and not restricted by law (Hegarty et al., 2002;
Katafiasz and Bartlett, 2012; FAO, 2013; Pickrell and
Hueston, 2014).

The Centers for Disease Control and Prevention
(CDC; Atlanta, GA) have associated 148 disease out-
breaks reported from 1998 through 2011 with raw milk
or raw milk products, and reported that 82% of the raw milk-associated outbreaks where age data was available involved mostly children (CDC, 2013; Robinson et al., 2014). Outbreak data suggest that the chance of becoming ill from consumption of raw milk is about 150 times greater than the risk from consuming an equivalent amount of pasteurized dairy products (CDC, 2013; Claeys et al., 2013).

The controversial topic of whether raw milk should be sold legally in Canada is an important issue. Since 1991, there has been a federal prohibition on raw milk sales in Canada. Approximately 88% of Canadian dairy farmers consume raw milk with legal access to the milk, whereas 2% of Ontarians consume milk without a legal supply (Young et al., 2010). This illegal market for raw milk is a concern for both advocates and opponents of raw milk, because farmers who contribute to the supply are not educated on proper protocols for producing raw milk for human consumption (McIntosh and Canadian Consumer Raw Milk Advocacy Group, 2014).

Global sales for raw milk show that Australia has similar prohibitions as Canada for raw milk sales, whereas the EU has tight regulations on the sale of legal raw milk. In approximately half of the states of the US, raw milk sales are legal; however, interstate transfer is prohibited (Australia Food Standards Code, 2012; Langer et al., 2012; Baars, 2013). Some European nations such as Belgium and Italy legally sell raw milk through vending machines and on-farm sales; however, boiling of raw milk before use is mandatory for the consumer (Tremonte et al., 2014). A Royal Decree has been published in Spain to ensure the hygienic–sanitary quality and safety of raw milk, enforcing European law. This decree regulates the control of traceability and quality of raw cow milk. It establishes a computer management system of traceability (named LeTRA Q) that declares the guidelines that should be followed in sampling and in the dairy laboratories. In addition, the Royal Decree makes it obligatory to carry out several controls on the farm through the milk process (de las Morenas et al., 2014).

Traceability systems facilitate the provision of quality signals to consumers. If the market adversely selects low quality or unsafe food in the absence of information signals to consumers, market failures occur. Consumer behavior, preferences, and attitudes toward consumption of dairy products differ among countries and are not solely attributed to sensory factors (Francesconi et al., 2010; Robb et al., 2007; Zhang et al., 2012; Kumar and Babu, 2014). A study posits that sensory, health-related, convenience-related, and process-related factors (e.g., organic, animal welfare, or genetic modification) are important for consumers’ perceptions about dairy product quality (Grunert, 2005).

Consumers’ willingness to pay (WTP) for food traceability has received increasing attention due to increasing concerns about food safety and results internationally; however, results vary across studies and regions. For example, Loureiro and Umberger (2007) showed that both traceability and country of origin are less valued than certification of USDA food safety in a study on consumers’ relative preferences of labeled rib-eye beef. In contrast, Lee et al. (2011) indicated that consumers in Korea are generally willing to pay a 39% premium for traceable imported beef over similar beef without traceability. A study conducted on the WTP for traceable meat in Canada showed that the participants were more willing to pay for products in which traceability and quality assurance were combined (Hobbs, 2003). Hobbs et al. (2005) examined economic incentives for implementing traceability systems in the meat and livestock sector in Canada, and found that without quality verification, traceability is of limited value to individual consumers and suggested that bundling traceability with quality assurance can deliver more value of traceable food products. Their findings suggest that consumers would pay a higher premium for valuable attributes (such as transparency and assurance) attached to traceability than for traceability alone. Consumers’ WTP for traceable pork, milk, and cooking oil in China showed that the age of consumers, educational level, perception of safety, and the average price, are the main determinants of consumers’ WTP for the traceable products (Wang et al., 2009; Zhang et al., 2012).

Improvement of food traceability systems is aimed at restoring consumer confidence in food safety and quality, in part by being able to provide consumers with more information about the origins of food, as well as the ingredients they contain. However, it is important to recognize consumers’ opinions and beliefs associated with traceability, as well as their preferences for information provision (Van Rijswijk and Frewer, 2012).

Some studies have shown that dairy products with nutrition claims have a greater effect on consumer choice. Nutrition highlights with recommending descriptions or contents of a nutrient content on the package could also enhance the rate of preference among consumers (Gelici-Zeko et al., 2013; Long et al., 2013). However, consumers are demanding more information about the actual quality standards of the food they eat; therefore, transparency about the ingredients used, as well as proven genuineness of origin for distinctive products, is becoming increasingly important (Magliulo et al., 2013). An Australian study indicated that nutrition education for participants in a weight loss trial influenced their behavioral and control beliefs relating to the consumption of dairy products. The results of the
study showed that when consumers are educated and informed of the products, as well as when they have the ability to understand dairy food labels, their attitude toward the dairy products are more likely to change in comparison to uninformed consumers (Nolan-Clark et al., 2011).

Semi-structured interviews with consumers in 4 European countries focused on the need for traceability, the preferred means of communication, labeling, and bodies held responsible for traceability and dealing with fraud. The results of this work showed a clear consumer need for varied information about food and the production processes involved. Rigorous and accountable traceability systems may assist in making such information available to consumers (Trichterborn et al., 2011).

METHODS

A paper-and-pencil structured survey was used in September 2014 at the University of Guelph to gather preliminary data to better understand consumers’ confidence in milk and dairy products, and the how they value the traceability of dairy products in general. A total of 75 undergraduate students studying at the University of Guelph participated in the survey with an average age of 21 yr. Eighty percent of the participants were female, and 90% of the participants were Canadian citizens. Seventy-five percent of the participants drank milk. We detected no significant correlation between drinking milk and sex or between drinking milk and citizenship ($P > 0.05$). Participants had different backgrounds and training. They were included in the research because of their interest in food research and as representatives of average young consumers. It was not possible to influence the number of females and males included in the research, so their sex status was only registered.

RESULTS

The outcomes of the survey proved noteworthy. Of the group, 31.6 and 21.1% of the nonconsuming respondents were lactose intolerant and had allergies to milk, respectively. We detected a significant negative correlation between participants who were lactose intolerant and drinking milk ($P < 0.05$), meaning that a lactose-intolerant person was less likely to drink milk. There was also a significant negative correlation between having allergies and drinking milk ($P < 0.05$).

However, only 42.3% of the respondents reported that they strongly trust the Canadian dairy industry when it comes to food safety and are very confident that Canadian milk and dairy products are safe. Only 18.5% of the respondents who consumed milk every day and 20.8% of respondents who consumed milk a few times a week strongly trusted the Canadian dairy industry. Fifty percent of the respondents who sometimes follow milk or dairy recalls indicated that they would very much change their consumption if a product they currently consume were recalled.

Sixty-three percent of the respondents who often read labels on different food products also read labels on milk or dairy products, and 61% of the respondents indicated that labels on different food products, as well as on milk or dairy products, strongly influence their purchase. Seventy-five percent of the respondents who always read labels on milk or dairy products indicated that information about the product strongly influences their purchases. We detected a significant correlation between reading labels and the influence of labels in purchasing milk and dairy products ($P < 0.05$).

Consumers’ WTP for traceable milk and dairy products on new market products (organics, raw milk) was also questioned. Seventy-one percent of participants responded that they currently do not consume raw milk at all, and only 1.3% said they did. However, the percentage of nonconsuming participants declined to 40% and the percentage of participants who reported they would be willing to consider purchasing raw milk if a tracking system were implemented increased to 9.3%. The results showed that 55.8% of the respondents who did not consume raw milk would still not purchase traceable raw milk.

Twenty-eight percent of survey participants indicated that they never purchase organic milk under current regulations (i.e., untraceable organic milk), and 4% of the participants indicated that they always do. However, the percentage of participants who would consider always purchasing traceable organic milk increased to 27%, whereas participants that still would not purchase traceable organic milk declined to 12%. The results showed that if the dairy sector could guarantee that the product is in fact organic, 53.8% of the respondents who often purchase current organic milk (i.e., untraceable organic milk) would consider always purchasing traceable organic milk.

DISCUSSION

Even though it was not assessed specifically in the survey, the level of consumers’ knowledge on food traceability seems unprecedented. No survey respondents requested further information or explanation about food traceability, and all were comfortable with the concept. Not only did respondents appear to understand what food traceability was, but they seemed to appreciate the functionality of food traceability as well as the
benefits it can provide for consumers. Food traceability systems have been introduced in many countries to reduce consumer uncertainty from farm to table, in terms of quality, integrity, and safety. Results of the survey show that the effect of food traceability on food systems has been questionable. Respondents seemed to understand the value of food traceability but would not necessarily support products that follow traceability procedures. However, survey results suggest that the concept of traceability is well understood by consumers. Our results show that consumers are aware of the industry’s capabilities in tracing and tracking products. The industry’s determination to respond to this growing recognition remains unknown.

In terms of dairy products, consumer confidence was lower than expected. When asked, fewer than half of consumers trusted the safety of dairy products, which was surprising. Most dairy products in Canada are produced and manufactured in the country. Concerns of disjointed standards with trading nations should not be a factor for dairy products in Canada.

Regarding traceability issues, consumers could be segmented into 3 different groups in this study: those with a negative or neutral view on food safety (system efficiency); those recognizing the value of information on less popular dairy food products (market-based sentiments), and those disclaiming health issues related to dairy products (capacity-enabling attributes). Figure 1 demonstrates how these food traceability influences in dairy interact with each other and relate to the consumer. The respondents among these 3 clusters indeed differed in terms of their attitudes toward food traceability. For the first cluster, respondents expressed concerns about food safety, and the data suggest that many do read labels to seek more information about food products and dairy products. Distrust of dairy products is empirically palpable, which is essentially related to food traceability’s effectiveness in protecting the public.

The second cluster of consumers indicates that information provided at points of purchase is consumed and could add more value to organically produced dairy products and raw milk—products that traditionally cater to smaller market segments. This is an interesting market-based outcome. Even if the commercialization of raw milk is prohibited, many respondents acknowledged that they consumed raw milk. This was a surprising finding that could be interpreted in 2 ways: Of those who are not concerned about the safety of milk and dairy products, their behavior is consistent with their interpretation because raw milk can be more harmful than pasteurized milk or dairy products made of pasteurized milk. Results suggest that respondents would be 6 times more likely to purchase raw milk.

Figure 1. Market-oriented traceability influences on dairy consumers. Color version available online.
if the product were traceable. Respondents would be twice as likely to purchase organic milk if it were traceable. If the integrity of food chains can be preserved and demonstrated through proper food traceability, more value is created in the retail sector. The demand for organic foods continues to increase, and the dairy sector could capitalize on this opportunity by utilizing food traceability more effectively.

The third cluster has a public health component to it. Unexpectedly, a great portion of respondents cannot consume dairy products. More than a quarter of respondents identified as lactose intolerant; this is a significant portion of our sample who did not qualify as dairy product consumers. Perhaps many of these respondents decided to restrict themselves from eating dairy products without a diagnosis from a health professional. This may not be a public health issue but more of a dietary preference. The role of food traceability has a meaning for consumers with health conditions or health preferences that would prevent them from eating more commonly consumed foods. Dairy is used in many different products and traceability can serve a valuable purpose in this context. Such a cluster could become a capacity enabler (i.e., something that could generate resources and create economic opportunities) for food traceability.

Our study results suggest that information can increase the market share of certain products (marketing dimension). In this area, the Internet is used as the distribution channel for the presentation of traceability data in a user-friendly manner and the dissemination of knowledge.

Some limitations should be considered when interpreting results of this study. The survey involved a small group of respondents. As this was an exploratory study, our intent was to simply assess the perceived value of tracing and tracking products across dairy food chains. The survey was conducted in a developed market with highly educated individuals. The need for traceability can be extended to other economies, but reasons for needing traceability may differ from one market to another. For example, in some countries and economies, traceability is required for survival and food safety, whereas in mature economies, consumers expect traceability to support product integrity.

CONCLUSIONS

Food traceability is a concept understood by an increasing number of consumers who are familiar with the capabilities of the food industry. This study demonstrated, to a certain degree, how food traceability can serve strategic purposes beyond food safety. Traceability could not only add value to current products available to consumers, but it could also empower consumers to protect themselves. Traceability could also support firms in developing new markets segments that have consistently rejected products such as organic or raw milk. The dairy industry provides a useful narrative account of how traceability can change a consumer’s perspective on, and the market value of, a product. Developing product traceability in the dairy industry clearly involves developing connections between consumer knowledge about tracing products and the market itself. Solving the need to more effectively trace dairy food products is not so much a question of managing or controlling routines as it is to understand how markets will react to offerings from the dairy sector. Consumers’ knowledge about traceability is real and industry may feel compelled to adjust in the near future. By understanding the role of traceability in the dairy industry, producers can create clearer markets and provide information to specific targeted segments. By using a larger and broader sample, future studies could expand beyond the dairy industry to better understand how other food categories could be affected by traceability in the future.


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