Animal identification: links to food safety

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Summary
Improvements in food safety in the United States of America are currently limited by the lack of an open, reliable and uniform animal identification system. Public health would benefit from the development of such a system because this would permit accountability for and prevention of food safety hazards, including residues and harmful pathogens. In addition, the public would benefit because data collection and long-term research studies are currently hampered by the lack of animal identification. Understanding of the ecology of food-borne pathogens in the production and handling period before slaughter needs to be improved. Animal identification will permit packers and consumers to reward producers for using food safety-related production practices. Food animal producers do not regularly receive an economic advantage for voluntarily undertaking food safety-related production practices. As a result, the original source of many food animals that enter official establishments is unknown. However, the hazard analysis and critical control point system allows some producers to offer identified animals under verified production control programmes or to enter into agreements with packers with regard to the food safety status of animals.

Keywords

Introduction
This paper does not seek to encourage a specific animal identification system or discuss the various organisational positions on animal identification in the United States of America (USA). Rather, the authors discuss the market forces in the USA that currently drive the production sector to use animal identification mechanisms to ensure food safety, highlighting some of the advantages to be derived from the use of identification.

The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) has employed animal identification as an element of various disease eradication programmes (e.g. programmes against tuberculosis and Aujeszky’s disease or pseudorabies). However, the USDA has never used animal identification in the animal production or the slaughter/processing industries to ensure food safety. Traditionally, the inspectors of the USDA Food Safety and Inspection Service (FSIS) at each abattoir have been individually responsible for determining whether a particular carcass and products thereof are safe, wholesome and unadulterated. Conversely, abattoir (official establishment) personnel have not been responsible for determining whether the animals or the carcass and products thereof were safe, wholesome and unadulterated. As a result, animal identification to ensure or verify product status, or even production practices, has not been part of the food safety system in the USA.
However, since the adoption of the ‘hazard analysis and critical control point’ (HACCP) system by the USDA FSIS in 1996, the relationship of the parties has changed. One of the goals of this paper is to discuss how this altered relationship creates a need for a link between the animal producer and the slaughter/processing industries through the use of animal identification to ensure food safety. In addition, the authors discuss certain missing links to food safety caused by the inability to adequately research and create the databases necessary to understand the ecology of harmful pathogens.

Background

As early as the mid-1980s, the FSIS received recommendations from the Food and Nutrition Board of the National Academy of Sciences on how the existing meat and poultry inspection systems could be modernised. After conducting scientific evaluations of the meat and poultry inspection programmes, the Food and Nutrition Board released a report in 1985, identifying the components of an optimal system for meat and poultry. One of the components recommended in 1985 was the ability to trace a product back to the producers. The 1985 report of the National Academy of Sciences advised as follows:

'A traceback and recall system from final sale to producer for all animals and products destined to the human food supply was recommended by the committee as an essential step for the generation of data that are important to the prevention of disease in humans and that will enable processors and the government to recognise potential hazards in the food chain' (10).

The report recommended an HACCP system using plant personnel in day-to-day monitoring of critical control points for each process conducted and FSIS supervision to ensure compliance. The HACCP system had been used by some food production companies for many years, and was considered to be a logical and simple, but specialised system for identifying those points during food production which could result in a hazardous situation, and taking steps to control those ‘critical control points’.

In the early 1990s, the pervasive attitude among members of the industry (and even among some regulators) was that most food-borne pathogens are a natural part of the environment and cannot be effectively controlled (1, 3). The idea that the Government would introduce standards for food-borne pathogen reduction, and testing of raw products for bacterial contamination, was not seriously considered. However, following the outbreak of E. coli O157:H7 in Seattle in 1993, which resulted in several deaths from undercooked hamburger meat sold by a national restaurant chain, regulatory attitudes and consumer expectations changed. Regulators and industry began to focus on emerging food-borne pathogens in raw products and the potential of these pathogens to harm consumers. Vigilance to potential food-borne hazards in other countries was also heightened (e.g. bovine spongiform encephalopathy [BSE] in the United Kingdom in the late 1980s).

Both industry and the Government were becoming aware that harmful pathogens were entering the food supply through a number of pathways. Clearly, standards that were acceptable in the past may not necessarily meet public health expectations currently or in the future. For example, public health researchers identified pathogens associated with foods initially considered as ‘safe’, such as leafy green vegetables, eggs, and fruit juices. Researchers also encountered increasingly worrying public health consequences associated with antimicrobial resistance. Although bacterial adaptation to environmental pressures was recognised, it had been considered a short-term effect. Researchers began to understand that harmful food-borne pathogens were adapting to traditional processing procedures and were developing the ability to survive changes in pH, heat and drying.

In 1995, the FSIS began to pursue a broad, long-term science-based strategy to improve the safety of meat and poultry products and better protect public health by proposing the HACCP programme. The strategic goal of HACCP was to reduce the risk of food-borne illness associated with meat and poultry products to the maximum extent possible. The HACCP strategy included proposed requirements for all federally inspected meat and poultry plants to reduce pathogenic microorganisms that can cause food-borne illness. The programme, finally approved in July 1996, required meat and poultry processing industries to adopt procedures that systematically prevent food safety hazards, and meet specific food safety performance standards (4).

These changes improved the ability of government to hold industry accountable for following preventive procedures and for meeting appropriate food safety standards. However, because of a lack of legal authority, this comprehensive approach did not include animal identification requirements which would have permitted traceback to either the producer, from whom the animal was purchased, or the farm of origin. The role of the FSIS in animal and egg production food safety is, within the limits of the authority granted and the resources available, to serve as a facilitator and co-ordinator of research and other activities designed to encourage the development and implementation of animal production technologies and practices that can improve food safety. The FSIS is not authorised to mandate specific production practices on the farm, such as animal identification. However, the FSIS expects that continued public concern regarding food-borne pathogens and the adoption of HACCP and food safety performance standards within slaughter and processing establishments will increase incentives for improving food safety practices at the animal production level.

In only a few years, the regulatory landscape for meat and poultry processing has changed. Packing plants are assuming
full responsibility for the safety of the product produced. Packing plants can be subject to the suspension of inspection services in the event that the product is not produced in conformity with the HACCP plans for that plant. In addition, if a processing plant produces raw ground beef that reaches consumer marketing channels containing E. coli O157:H7, such a product is considered to be adulterated and should be recalled. If the products of a packing plant contain illegal animal drug or pesticide residues, the product is also subject to condemnation. The new regulations implementing performance standards for Salmonella contamination provide a mechanism for regulators to determine the adequacy of the HACCP plan for a plant. These landmark changes have begun to alter the packing and processing industries and to place new requirements not only on the packing and processing plants, but also on suppliers of these plants. A ripple effect to suppliers is beginning to emerge as each segment of the food chain demands assurances related to food safety.

Technological innovations for pathogen reduction in the processing industry

An immediate need for the packing industry has been to develop a means to limit carcass contamination by pathogens such as E. coli O157:H7, Salmonella and Campylobacter. Innovative technologies have been tested and proven effective, for example carcass steam pasteurisation, spray-washing, irradiation and chemical interventions (trisodium phosphate, ozone, hydrogen peroxide, acetic acid and a commercial sanitiser containing a blend of acids). Packing plants discovered that the use of one of these technologies could reduce the prevalence of harmful pathogens on carcasses, but that the use of several of these technologies had a synergistic effect. This is known as the ‘multiple hurdle approach’. The meat and poultry industries have recognised that no single sanitary process is able to prevent infection of a raw product with harmful pathogens during slaughter and processing, but that the use of several of these processes may have a very strong beneficial effect.

Researchers are currently focusing on the product entering the plant as an opportunity for further pathogen reduction, and for this opportunity to be realised, animal identification will be essential. As new on-farm technologies are developed and implemented, animal identification techniques enable documentation between producer and packer to certify that the animals entering a plant meet production criteria desired by plant management. Animal identification is necessary to segregate animals that have a documented production history from those of unknown background, and to facilitate the reward of producers in the marketplace.

Residues

Under the HACCP system regulations (5), a food safety hazard is defined as any biological, chemical, or physical property that may cause food to be unsafe for human consumption (Sec. 417.1). The chemical food safety hazards that might be expected to arise specifically include chemical contamination, pesticides and drug residues (Sec. 417.2(a) (3) (iii), (a) (3) (iv) and (a) (3) (v)). An animal may be marketed with an illegal residue due to a variety of reasons. Among these is that the last dose of a drug was administered without an adequate withdrawal period (11). For each hazard that is reasonably likely to occur, an HACCP plan must identify the preventive measures that the establishment will apply to control the hazard. Animal identification records will enable plant management to hold suppliers accountable for residue avoidance.

The Center for Veterinary Medicine of the Food and Drug Administration (FDA) is responsible for the enforcement of residue violation legislation under the Food, Drug and Cosmetic Act. As part of the apparatus for enforcement of this Act, the FDA relies on traceback methods, such as animal identification, to identify those producers or others who may have been involved in marketing an animal with illegal drug residues. Officials at the Center for Veterinary Medicine are concerned that the reduction in the number of animals currently identified, as a result of animal health identification requirements being phased out, will reduce the effectiveness of traceback to identify the source of illegal drug residues. As mentioned previously, the USDA rules governing animal identification relate to the movement and handling of animals in inter-State commerce for the purposes of controlling or eradicating animal diseases in livestock, not food safety. As animal disease eradication programmes come to a conclusion, fewer animals that move in inter-State commerce will be identified. In addition, because no FSIS requirement exists for maintaining animal identification data on animals entering an official establishment for slaughter, tracing the source of animals is likely to become more difficult.

Residue control is one of the pivotal areas which drives the development of meaningful animal identification. Packers will seek documentation on the animals that are entering their establishments to check for residues and other hazards. At the same time, some unscrupulous producers may market an anonymous product, hoping the system will fail to identify a recently treated animal.

Research into the ecology of food-borne pathogens

In trying to improve the safety of the food supply, researchers first try to understand the ecology of a particular pathogen to identify steps that can be adopted to reduce the likelihood that the pathogen can reach the end consumer. While the impact of a pathogen on the consumer is often manifested after consumption of improperly prepared food, the problem
commences with infected animals on the farm. Carrier animals that harbour bacteria may shed the pathogen into the environment. For *E. coli* O157:H7, information regarding the duration and extent of the carrier state is limited. Short-term studies by Hueston and Fedorka-Cray have analysed the effects of exposure to an infected population (8). However, long-term studies are rare. One possible factor is the lack of animal identification to document animal movement, which hinders the ability to design prevalence studies of farm practices. Similarly, at the packing plant, because of a lack of animal identification, studies that traceback pathogen incidents are limited.

The development of a database that would allow probability-based national sampling of herds is required – both for herd management and the collection of data on food-borne disease agents. Few existing databases hold information on herd management and disease agent prevalence. Furthermore, no known national database collates production data obtained from outbreak investigations. If viable animal identification systems existed that could be relied upon for use in an analysis of the relationship between production practices and pathogen incidents, researchers would have a valuable tool to improve the understanding of, and develop barriers to impede the development of harmful pathogens in the food supply (1, 2, 7).

**Backward/forward tracing in the event of an outbreak of a food-borne disease**

In discussing animal identification, analysts typically concentrate on the effect of animal identification on farm income and ignore the farm-to-table food safety approach. Animal identification that allows traceback throughout the farm-to-table continuum would allow the cost of food-borne illness and the benefits from preventive measures to be attributed to the appropriate segments of the food chain.

Additionally, a reliable animal identification system would enable public health officials to trace forward to prevent consumption of animal products that are found to have been exposed to latent diseases or harmful pathogens. A hazard analysis of processing steps from the farm to the point at which animals are presented for slaughter, and subsequently into processing and retail, would enable public health officials to take informed steps to protect the public from pathogens, diseases or violative residues. Buchanan and Whiting suggest that predictive microbiological modelling could be realised by breaking the complex chain of events associated with the manufacture, preparation and consumption of foods into discrete steps (2). Hathaway and McKenzie suggest that information and data requirements may extend beyond the slaughterhouse to the consumer or back to the farm and port of origin (7).

For example, characteristics of an animal, such as age, species, and pertinent environmental conditions, such as the season of the year and geographic region, might be noted when using an HACCP plan, because those factors could affect the suitability of the animal for human consumption. The health status of herds and flocks could be determined in advance of transportation to slaughter so that high-risk animals could be separated from low-risk animals for the purposes of both slaughter and inspection. These data, in combination with pathogen baseline data and microbiological profiles of products, could help identify farm management and animal marketing practices that affect food safety. However, for the purposes of this paper, it is sufficient to indicate that the lack of a reliable animal identification system inhibits the ability of researchers to develop the data necessary to track food-borne pathogens and to identify methodologies to exclude harmful food-borne pathogens and thereby protect consumers.

**Control of zoonotic pathogens**

The ability to identify the existence of zoonotic conditions in animal carcasses at the abattoir is sometimes limited. The critical control point, in HACCP terminology, may be more appropriately located at pre-harvest. Animal identification is necessary to provide effective tracebacks and permit management improvements to prevent further zoonotic outbreaks and reduce the economic burden to both the packer and the producer (6, 12).

For example, cysticercosis is a continuing problem in cattle in the USA. While the organism occurs only occasionally in feedlots, the majority of the reported cases occur in relatively large outbreaks in a very small number of feedlots. Humans are the definitive host of the adult tapeworm *Taenia saginata*. According to reports, the sensitivity of slaughter inspection methods to identify *Cysticercus bovis* cysts is a function of the number of the sites inspected and the number of cuts made in these sites. In a study by Maeda et al., examination of the traditional inspection sites (including heart, masseter muscle, tongue and diaphragm) would be expected to result in a sensitivity of 17% (9). To reduce the likelihood of affected animals entering the food supply, traceback to identify the source of the infestation, which may be the farm of origin, is necessary.

A similar situation exists for leptospirosis in swine. Dissemination of information on outbreaks enables producers to make adjustments in vaccination programmes to prevent leptospirosis infection in swine and/or cattle. Although *Leptospira* spp. are not likely to survive in food and infect consumers, the organisms are a threat to workers in packing plants and to USDA inspectors, through mucosal contact.

**Future requirements**

The authors have outlined the concerns regarding food-borne pathogens in the USA and discussed the predicted effect of the
implementation of HACCP in slaughterhouses on the expectations of industry for animals sent for slaughter. The renewed concerns among consumers about residues in the food supply are emphasised, as well as the need for animal identification to enable research on the ecology of pathogens. The specific need to be able to attribute risk to each segment of the food chain when food-borne illness occurs has also been recognised. These needs are contrasted with the reality that current animal identification systems imposed by animal health concerns are being phased out, because of the success of the various animal disease eradication programmes. Given this framework, some of the future needs for animal identification systems in food safety risk management need to be identified.

**Verified production control programmes**

To meet the current requirements of the packing industry for documentation to certify that animals are being marketed without violative residues and with quality enhancing production practices for leanness and tenderness, and to ensure a minimisation of harmful pathogens, producers and producer organisations are developing verified production control programmes. These integrated systems involve quality control programmes on the farm that are overseen by the producer and verified by a third party. A co-operative farm organisation, or similar producer organisation, or a state regulatory agency might manage these programmes. The implementation of HACCP systems is expected to lead packing plants to demand that producers meet certain specifications for the animals being marketed. Similarly, producers who meet these food safety criteria require a marketing system that will enable them to receive the benefit for using food safety-related production practices. In either case, the marketing system will need to include animal identification to ensure that animals raised under specialised production control programmes maintain that identity and value in the marketplace.

**Niche marketing**

Although marketing systems should benefit producers who add value to a product and a means to identify such a product throughout the market channels, such food safety market channels do not yet exist. Current market systems encourage production of a generic product and packers cannot always identify the responsible producer. The result is a greater food safety risk, resulting in the reduced ability of the packing industry to control residues and pathogens. This in turn results in greater food safety risks for packers and reduced prices for producers.

Niche markets are being created to allow producers to receive a financial benefit for quality and food safety improvements with regard to their product. For example, the Agricultural Marketing Service of the USDA provides a certification programme for producers of Angus beef and for those producers who intend to market a product to the European Union that is certified to be ‘non-hormone treated’. Additional niche markets are being developed for organic or residue-free products. A programme to document production of a trichinae-free product is being developed through co-operation by the pork industry, FSIS and APHIS.

However, the development of these niche markets is accompanied by the introduction of changes in the general market. The National Pork Producers Council manages an industry quality assurance programme, and its Pork Quality III status is currently required for producers marketing to slaughterhouses in the Midwest. Animal identification systems maintain credibility for producers of these value-added products.

**Future animal identification systems to improve food safety**

An animal identification system that will assist and improve food safety should be open, reliable and uniform. In an open system, government has access to information records and the system meets the needs of the government in terms of record-keeping and reliability. Industry support is critical to ensure that the information is reliable. Both industry and government benefit from an animal identification system that is properly maintained without direct intervention by government or industry organisations. Industry leaders must educate their members so that animal identification systems benefit them in many ways, including documenting food safety, and remind them that a personal commitment is required of producers. With regard to uniformity, if the systems are to be used as traceback and traceforward mechanisms, the systems used in each state must have compatible, if not integrated, databases.

The remaining issue is whether animal identification systems should be voluntary or mandatory. Discussions on the costs and benefits of each approach are ongoing. A voluntary approach is underway at present, because this provides flexibility in design, time to study the practicality of the system, and an opportunity for producers to buy into the process.
Identification des animaux : les liens avec la sécurité alimentaire

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Résumé
Aux États-Unis d’Amérique, les progrès en matière de sécurité alimentaire se heurtent actuellement à l’absence d’un système d’identification des animaux à la fois ouvert, fiable et uniforme. Un tel système serait bénéfique pour la santé publique, car il faciliterait la recherche des responsabilités en cas d’intoxications alimentaires et améliorerait la prévention de ces risques, y compris ceux liés aux résidus et aux agents pathogènes dangereux. L’intérêt de l’identification des animaux serait de permettre la collecte de données et la réalisation de recherches à long terme. L’écologie des agents pathogènes responsables des toxi-infections alimentaires dans les phases de production et de manipulation précédant l’abattage pourrait ainsi être mieux connue. L’identification des animaux permettrait aux industriels et aux consommateurs de récompenser les éleveurs qui recourent à des pratiques de production privilégiant la sécurité alimentaire. Les producteurs n’ont actuellement aucun avantage économique à adopter de telles pratiques. En conséquence, le plus souvent l’origine des animaux qui arrivent aux abattoirs placés sous contrôle officiel reste inconnue. Toutefois, le système d’analyse du risque et du point de contrôle critique (HACCP) permet à certains éleveurs de proposer des animaux identifiés dans le cadre de programmes homologués de contrôle de la production, ou d’accords relatifs au statut des animaux en termes de sécurité alimentaire, conclus avec l’industrie de la viande.

Mots-clés

Identificación de los animales y su relación con la protección alimentaria

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Resumen
En los Estados Unidos de América, la introducción de mejoras en la protección alimentaria tropieza hoy con la falta de un sistema abierto, fiável y homogéneo para identificar a los animales. La salud pública mejoraría si se implantara un tal sistema, que haría posible no sólo prevenir accidentes, por ejemplo la presencia de residuos o patógenos peligrosos en los alimentos, sino también, llegado el caso, determinar sobre quién recae la responsabilidad de un accidente de ese tipo. También el público saldría beneficiado, en la medida en que las actuales dificultades para identificar a los animales obstaculizan la obtención de información y la práctica de estudios o investigaciones a largo plazo. Es necesario entender mejor la ecología de ciertos patógenos de transmisión alimentaria durante las fases de producción y manipulación previas al sacrificio. La identificación de los animales serviría además para que los distribuidores y los consumidores pudieran recompensar a los productores que aplicaran métodos...
acordes con los principios de la protección alimentaria. Los productores de alimentos de origen animal no siempre encuentran ventajas económicas al aplicar de modo voluntario métodos de protección alimentaria. De ahí que se ignore el origen de muchos de los animales destinados al consumo humano que llegan a los mataderos oficialmente controlados. Sin embargo, el sistema de análisis de riesgos y control de puntos críticos (HACCP) sirve para que algunos productores ofrezcan animales identificados con arreglo a programas homologados de control de la producción, o a los acuerdos con las industrias envasadoras relativos a la sanidad de los animales.

**Palabras clave**


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**References**


