Ranking of food safety risks in pork from organic and free-range production systems

Sandberg, M.,*
Nygaard, C., Alban, L.

The Danish Agriculture & Food Council, Copenhagen, Denmark

*Axelborg, Axeltorv 3, 1609 Copenhagen, Denmark
e-mail: msa@lf.dk

Abstract

The objectives of this semi-quantitative risk assessment were to identify, assess and rank food safety risks in outdoor pig production (organic and free-range) compared to indoor pig production (conventional) in Denmark. In addition, high-risk pork products would be identified. Finally, risk-reducing strategies for handling the identified agents would be suggested. Data were obtained from the literature as well as in-house statistics. Data describing tetracycline-resistant E. coli in outdoor pigs were available from the Qualysafe project. The OIE framework for risk assessment was applied.

No differences were identified between indoor and outdoor pig production in regard to Salmonella, Campylobacter, Y. enterocolitica and T. spiralis (for the latter, all carcasses are tested). Humans might acquire T. gondii from consumption of sub-optimal heat-treated pork (core temperature <61°C) or pork products not previously frozen, lightly cured (<3.7% salt), smoked, or fermented where the meat originate from finishers or sows in outdoor-productions. Most of the pork intended for such productions is frozen prior to processing, limiting the risk to humans. The largest uncertainty was related to the likelihood of survival of T. gondii in the above mention products. Further research is therefore required.

Introduction

Healthy food, environmentally-friendly production and animal welfare are regarded by the public as being taken care of in a better way in organic and free-range production systems compared to conventional systems. The environmental-exposure for production animals in these systems could, however, lead to transmission of pathogens from wild to domestic animals and subsequently to humans. Food safety might then be compromised.

Only about 1.3 % of the around 20 million pigs slaughtered annually in Denmark originates from a free-range or organic production system. It is, however, a political goal to double the agricultural area used for organic agriculture production in Denmark before year 2020. In free-range and organic productions, sows and piglets are kept outdoor all year on fields in huts that act as shelters. Most of the finishers are kept indoor where they get water and feed, but have access to the outdoor environment. Today, many of the zoonotic enteric agents that might be present in the environment of domestic pigs are, at least to some extent, controlled by blockage of the transmission ways i.e.; treatment of sewage and manure, heat treatment of feed, ground water supply. Denmark has obtained an official EU status as area with negligible prevalence of Trichinella spp in domestic pigs. Testing for Trichinella is still conducted for all pigs irrespective of production system, because of trade requirements.

In Denmark, most of the organic and free-range pigs are slaughtered at one specific abattoir and no specific hygienic measures are taken when slaughtering these pigs. The withdrawal time for animals treated with antimicrobials in organic is the double of what is required in the conventional production, limiting the incentive to use antimicrobials in this production system. About 67% of the Danish organic pork production is exported to Germany, France or the United Kingdom. Moreover, organic pork is imported from the Netherlands to Denmark for production of products such as cured and fermented sausages.

Many outdoor pig herds are small; and are therefore not included in Salmonella sero-surveillance programme (requires > 200 finishers per year). However, the pork from these pig-herds is covered in the microbiologic surveillance conducted at all Danish pig abattoirs.

The objectives of this semi-quantitative risk assessment were to identify, assess and rank food safety risks in Danish pig production (conventional versus organic and free-range). In addition, high-risk pork products would be identified. Finally, risk-reducing strategies for handling the identified agents were suggested.

Materials and Methods

Data were obtained from the literature as well as in-house statistics. Data describing tetracycline-resistant E. coli in outdoor pigs were available from the Qualysafe project.

Risk assessment framework

A risk assessment (RA) framework given by the OIE was adopted with some modifications, and data were identified by conducting a literature search. The hazards included were zoonotic pathogens in pigs described in the veterinary scientific literature. Use of antimicrobials, antibiotic residues in pork and development of antimicrobial resistance were also evaluated to a certain extent.

The outcomes from each of the three steps of the risk assessment; release, exposure and consequence, were categorised into four groups: 0-3 (Negligible, Low, Medium or High). A similar scale was used for uncertainty in the outcomes. The final relative risk estimates were obtained by multiplying outcomes from the three steps. These risks are only relevant in the context of comparing one to another.

Table 1. Matrix showing possible outcomes of the assessment of Release and Exposure

		Exposure			
		Negligible	Low	Medium	High
Release	Negligible	0	0	0	0
	Low	0	1	2	3
	Medium	0	2	4	6
	High	0	3	6	9

Table 2. Matrix showing possible outcomes of the assessment of Release, Exposure and Consequences

		Consequences			
		0	1	2	3
Release x	0	0	0	0	0
Exposure	1	0	1	2	3
	2	0	2	4	6
	3	0	3	6	9
	4	0	4	8	12
	6	0	6	12	18
	9	0	9	18	27

Results

Hazard identification

Hazards included were: Salmonella, Campylobacter, Y. enterocolitica, Verotoxin producing E. coli (VTEC) and Brucella suis, T. gondii, T. spiralis, Taenia solium, Ascaris suum, Cryptosporidium, Giardia and zoonotic virses: Hepatitis E virus (HEV), Influenza virus and Noro virus. Use of antimicrobials, antibiotic residues and development of antimicrobial resistance were also evaluated to a certain extent.

Release/exposure assessment

At current, the most important risk of introduction of Salmonella into a pig herd in Denmark is regarded as being purchase of infected pigs. The environmental infection pressure of Y. enterocolitica seems also to be of less importance, also, pointing to trade of animals as the main factor for introduction of this zoonotic agent.

A high prevalence of Campylobacter in the live pig does not seem to play a role for food safety because of the major decimation of Campylobacter that happens during chilling (blast, tunnel or batch) of carcasses and further during storage at low temperatures. Campylobacter isolated from pork is mainly C. coli, and only 5-10% of the human cases of campylobacteriosis are caused by this serotype.

Studies of E. coli shows that the prevalence of tetracycline-resistance in E. coli is lower in the organic than in the free-range and conventional production – reflecting the lower amount of tetracycline used in outdoor pig production compared to conventional.

Toxoplasma gondii, Brucella suis and Trichinella might be present in wildlife. Hares might be infected with B. suis, whereas rodents, foxes and wild boar might be infected with Trichinella. However, at current there are no free-ranged wild boars in Denmark, and the prevalence of Trichinella in foxes is around 0.1%. For T. gondii, the cat is the final host whereas pig, sheep, goat and poultry are intermediate hosts.

The prevalence of T. gondii in conventional pigs is low. In outdoor-reared pigs the prevalence is assessed as being higher – especially in the sows because they are exposed to infected cats and rodents for a longer time. The results of a project conducted in 2009 in Denmark indicated that about 40% of outdoor-reared pigs have antibodies against T. gondii.

Pigs that are kept outdoor could be exposed to hares that harbour Brucella suis. However, the prevalence of this infection is currently regarded as negligible in organic and free-range pigs in Denmark. The last reported case of brucellosis in an outdoor pig farm in Denmark was in 1999 – and the infection was regarded as originating from hares. Moreover, Trichinella has not been found neither in outdoor nor in indoor-reared pigs for more than 75 years.

The prevalence of VETC is very low and T. solium is not found in Denmark. Ascaris and influenza were assessed as not being food-borne. Contact with pig faeces could, however, be a risk. For Listeria and Noro-virus, other sources than raw pork was regarded as more important.

Table 3. Outcome of a semi-quantitative risk assessment and relative ranking of food safety hazards in pig production (probability: 0= negligible, 1= low, 2= medium and 3= high). The relative risks might be compared between indoor and outdoor production. The uncertainty is given in brackets

Hazards	Release	Exposure	Consequence	Relative Risk (uncertainty)	
				Free-range	Indoor
Salmonella	1	1	1	1 (1)	1 (1)
Campylobacter	3	0	1	0 (2)	0 (2)
Y. enterocolitica	3	1	1	3 (2)	3 (2)
T. gondii	2	2	3	12 (3)	3 (1)

Consequences of a human Toxoplasma gondii infection

The most common symptom of toxoplasmosis in humans resembles influenza. However, toxoplasmosis in pregnant women might lead to abortion or foetal abnormalities. The prevalence of congenital toxoplasmosis in newborn in Denmark were screened from 1997-2007, revealing that 1.6 per 10,000 liveborn infants with congenital toxoplasmosis. Immune-compromised, e.g. HIV patients could also be affected seriously by toxoplasmosis.

Risk ranking

No differences were identified between indoor and outdoor pig production in regard to Salmonella, Campylobacter, Y. enterocolitica and T. spiralis (all carcasses are tested). However, the risk associated with T. gondii is larger in pork from outdoor compared to indoor production (Table 3).

Specific risk products and risk mitigation

Humans might acquire T. gondii from consumption of sub-optimally heat-treated pork (core temperature <61°C) or not previously frozen, lightly cured (<3.7% salt), smoked, or fermented products ready-to-eat, originating from finishers or sows

in outdoor-productions. Freezing or heat treatment will kill T. gondii cysts present in the meat destined for such productions. The largest Danish producer of free-range and organic pork production reports that there is no production of risk products based on free-ranged or organic produced pork in Denmark. Additionally, eighty percent of the pork used for sausage production in Denmark is pre-freezed (-12°C) and hence, the risk for T. gondii cysts is reduced to a large extent. The largest uncertainty was related to the likelihood of survival of T. gondii in the above mention products. Further research is therefore required in particular with respect to effect of salt on the survival of the parasite.

Discussion

The zoonotic risk associated with pork from outdoor pig production seems to be very equal to pork from conventional production. The low environmental pressure in Denmark might be explained by blockade of important transmissions routes for Salmonella, i.e. heat treatment of feeding, treatment of sewage and use of ground water. Salmonella and Y. enterocolitica as well as other of the included pathogens (e.g. Cryptosporidium) seems to survive well in water and manure. There are, however, many data gaps in regard to recirculation of the included pathogens in the ecosystem. More data from Danish wildlife, sewage and water are needed before more definitive conclusions can be drawn about the level of pathogens in the ecosystem and the infection pressure from the environment.

The most important route of transmission of T. gondii to humans is considered contact with oocyst in cat faeces (contaminated soil, vegetables and handling of indoor cat-toilets). Eating under-cooked mutton is also recognized as a transmission route for T. gondii tissue cysts for humans. Contrary, pork is usually heat-treated to a core temperature >61°C. Therefore, pork has been ascribed a very low risk from the 1970's and onwards when the indoor system for pig production was almost fully adopted.

Only surface decontamination methods are implemented at abattoirs. Hence, Toxoplasma cysts (which are harboured on the inside of the muscle) are not eliminated during slaughter, if present. Cysts are killed during heat-treatment. There are, however, some products like lightly cured and smoked filets and fermented sausages mildly cured (~ low salt content) where T. gondii could survive if present. To control this, pork used for processing of such products might be subjected to freezing for 24 hours at -12°C. This is widely practiced in Denmark. Knowledge about survival of T. gondii in smoked, lightly-cured and/or fermented or dried products is, however, limited. This is unfortunate because consumption of rose-cooked pork is on the increase as well as consumption of pork products with a low content of salt.

Conclusion

No differences were identified between indoor and outdoor pig production in regard to Salmonella, Campylobacter, Y. enterocolitica and Trichinella. The risk of humans acquiring infection with T. gondii is slightly increased when consuming sub-optimally heat-treated pork (core temperature <61°C) or not previously frozen, lightly cured (<3.7% salt), smoked, or fermented products originating from finishers or sows in outdoor-productions compared to similar pork for indoor production. This risk is mitigated when the pork is frozen prior to processing, and this is widely