



Source attribution by Quantitative Microbial Risk Assessment

Parameter	
Prevalence pigs	2.0% (Swanenburg 2019 Vet Par)
Prevalence cattle	1.6% (Opsteegh 2019, IJP)
Prevalence sheep	17.7/53.2% (Opsteegh 2010)

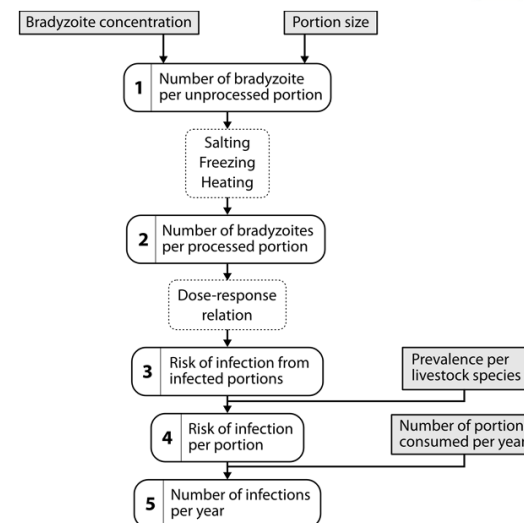
Risk from a portion of lamb meat is higher than from beef or pork

but

Interventions need to be effective on population level



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Data:

- Prevalence in livestock
- Bradyzoite concentration
- Effect of processing
- Dose-response relation
- **Number of portions and portion sizes by product**
- **Processing and preparation data:**
 - **Industrial**
 - **Consumer habits**

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Data sources

Parameter	QMRA I	QMRA II
Prevalence pigs	0.5% (vd Giessen 2007)	2.0% (Swanenburg 2019 Vet Par)
Prevalence cattle	2.0% (Opsteegh 2011)	1.6% (Opsteegh 2019, IJP)
Prevalence sheep	17.7/53.2% (Opsteegh 2010)	17.7/53.2% (Opsteegh 2010)
Bradyzoite concentration	10 ^{3.6} /100g (Opsteegh 2010)	10 ^{3.6} /100g 100x lower for cattle
Consumption data	VCP 1998	VCP 2010
Freezing effect	Kotula et al., J Food Protect 1991	Kotula et al., J Food Protect 1991
Heating effect	Dubey et al., J Parasitol 1990	Dubey et al., J Parasitol 1990
Salting effect	Dubey, J Parasitol 1997	Meta-analysis
Processing in industry	No freezing, recipes handbooks	50/75/90% freezing for minced meat , updated recipes
Consumer preparation	Heating: US data (FDA 1999) Freezing: 0% or 42.3%	Dutch data by product-type (Evers 2017) (Chardon 2016)
Dose-response parameter	r = 0.001535 type II in mice (AFFSA 2005)	r = 0.001535 type II in mice (Guo 2015 Risk Analysis)

I Opsteegh et al. (2011), Int J Food Microbiol 150: 103-114; II Deng et al. (2020), Int J Food Microbiol 314: 108380

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Results

Species	QMRA I ¹	QMRA II ²
Beef	67.6%	84.0%
Lamb & Mutton	14.0%	0.2% & 3.7%
Pork	11.2%	12.0%
Mix (beef/pork)	7.1%	0.1%

Predicted number of infections in pregnant women and congenital infections:

- QMRA I: 26359 * 29%³ = 7644
- QMRA II: 1214 * 29% = 352

Epidemiological data: 388⁴ (30-63% meatborne ~ 116-244)

¹ Opsteegh et al. (2011), Int J Food Microbiol 150: 103-114

² Deng et al. (2020), Int J Food Microbiol 314: 108380

³ Dunn et al (1999), Lancet 353: 1829-1833.

⁴ Kortbeek et al (2009). Mem Inst Oswaldo Cruz 104(2): 370-373.



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Influential parameters

> Sensitive

- heating temperature (10% lower temperature leads to 91% increase model output)

> Uncertain

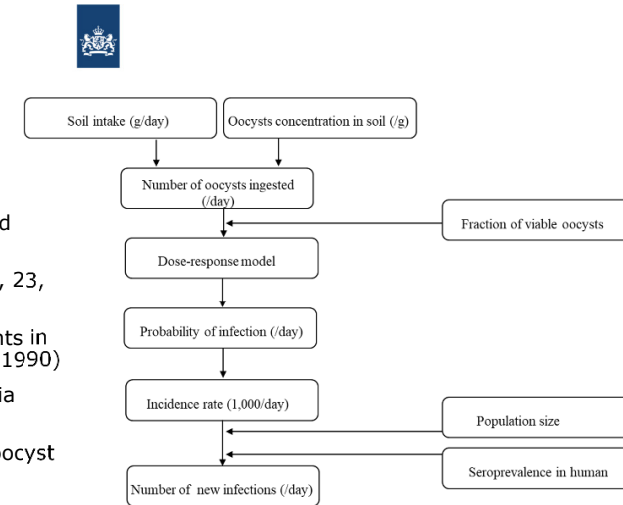
- heating temperature
- bradyzoite concentration
- **effect of salting**
- human dose-response parameter
- ...

Parameter	Sensitivity	
	treated	all
Bradyzoite concentration	0.4	0.4
Portion size	0.4	0.4
Salting: NaCl concentration	-0.9	-0.1
Salting: temperature	-0.6	0.1
Salting: duration (days)	-0.3	0.0
Freezing: fraction unfrozen	1.0	0.6
Freezing: temperature	0.3	0.2
Freezing: duration (hours)	0.2	0.1
Heating: temperature	-9.1	-5.4
Human dose-response parameter	0.5	0.5
Prevalence in livestock	1.1	1.1

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Environment

- > Developed magnetic capture-based detection method
- > 5/148 positive soil samples; 8, 12, 23, 48, 478 oocysts in 25g
- > Soil intake based on tracer elements in Dutch children (van Wijnen et al., 1990)
- > 9-26 times more infections than via meat
- > uncertainty soil intake, unknown oocyst viability



Deng et al., 2021 Sci Total Environ. 755: 143232



Social cost-benefit analysis

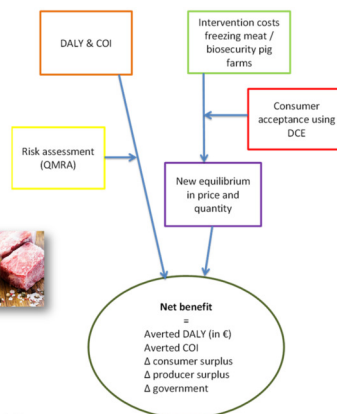
> Freezing of risky meat products

- Using QMRA-model to identify risky meat products
- ASSUMPTION: Imposed by law within min. EU



> Improved biosecurity on farms

- Only pigs as housing conditions might allow control
- Identification of high risk farms by serological screening at slaughter
 - No information on effectiveness of the intervention, on the components involved: assumptions had to be made w.r.t. effectiveness and costs
- ASSUMPTION: Imposed by law within min. EU



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Annual costs and benefits freezing meat intervention * €1000

	Filet americain		Beef steak			Biosecurity intervention	
Stakeholders	Min	Max	Min	Max	Stakeholders	Min	Max
Freezing companies	-975	-89	-4,811	-626	Farmers	-2,103	-701
	+975	+89	+4,811	+626	Slaughterhouses	-439	-482
						+439	+482
Consumers					Consumers		
Freezing costs	-975	-89	-4,811	-626	- Intervention costs slaughterhouses	-439	-482
DALYs averted	10,408	15,612	190	286	- DALYs averted	16	23
Patient costs	12	24	0.2	0.4	- Patient costs	0.02	0.04
Productivity losses	199	362	3.6	6.6	- Productivity losses	0.3	0.5
Consumer surplus	-907	-112	-2,722	-622	Government		
Government					- Healthcare costs	3	23
Healthcare costs	1,836	15,136	33.6	277	- Special education costs	0.006	0.2
Special education costs	3.2	143.3	0.06	2.6	Net costs/benefits	-2,525	-1,136
Net benefits	10,576	31,077	-7305	-625			

Suijkerbuijk, A. W. M., et al.(2019). "A social cost-benefit analysis of two One Health interventions to prevent toxoplasmosis." PLOS ONE 14(5): e0216615.

Follow-up from SCBA

KNS Koninklijke Nederlandse Slagers

WORD LID | Mijn KNS | Nieuws | Kalender | A - Z | Leden

5 stappen uit de praktijk voor een veilige en heerlijke Filet Americain

25-03-2021 | Leestijd: 1 minuut

Met ingang van de nieuwe hygiëncode geldt er een plicht van het invriezen van (de grondstoffen voor) filet americain om de parasiet Toxoplasma te inactiveren. Veel slagers werken al langere tijd met grondstoffen die diepgevroren zijn geweest, andere ervaren dat het onmogelijk is om een goede filet te maken zonder spikkels, vochtverlies of kleurverlies. Kortom er is behoefte aan een goede procedure beschrijving voor filet americain. Slager Nico Runderkamp van Slagerij Bakkertje te Volendam zet de 5 stappen op een rij die hij al jaren zet om een probleem-vrije filet te maken.

Vraag en antwoord

Is filet americain veilig en gezond om te eten?

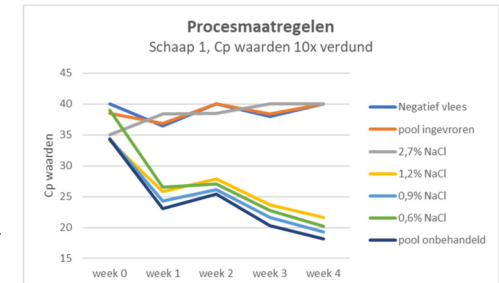
Is rauw vlees volledig veilig na invriezen?

Nee. Het invriezen van rauw vlees zoals filet americain bij -12 °C voor minstens 2 dagen doodt de parasiet Toxoplasma gondii. Maar bacteriën zoals listeria of salmonella kunnen nog wel overleven en later eventueel uitgroeien tot aantallen waarvan je ziek kunt worden. Daarom blijft het advies voor zwangeren, baby's en jonge kinderen, ouderen en mensen met een verminderde weerstand om géén rauw vlees te eten.

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Effect of salting – ongoing work (2020-2023)

- > PPS One health for meat products
 - WBVR, RIVM, WFBR, TNO
 - NVN, KNS, meat producers
- > Develop a cell-culture based viability assay
- > Determine the effect of NaCl, Na-lactate and Na-acetate on viability of *T. gondii* in meat



Opsteegh et al. (2020), Int J Parasitol. 50: 357-369

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QMRA – ongoing work (2020-2022)

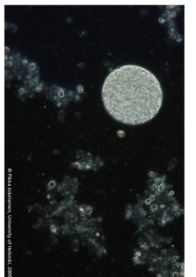
- > Toxosources WP2
- > To estimate the environmental transmission routes
 - QMRA
- > To provide an overview of transmission routes for pigs and cats
 - Systematic literature review
- > To quantify human exposure to Toxoplasma
 - Exposure survey
- > To provide an overview of relevant meat products
 - Handbooks, guidelines
- > To provide an overview of prevalence and risk factors of human infection
 - Systematic literature review, Bayesian hierarchical model



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In summary

- > One health parasitology @ RIVM
 - Veterinary (Z&O) and medical parasitology (IDS) in one institute
 - Focus on 5 zoonotic parasites
 - Collaboration
- > Toxoplasma
 - Disease burden
 - Epidemiological studies
 - Different approaches for source attribution
 - Intervention





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- › Alle deelnemende labs
Toxbron studie
- › Deelnemers Pienter studies



Points for discussion

- › Make (congenital) toxoplasmosis reportable
- › Patient inclusion case-control studies
- › Disease burden
 - Incidence of acquired and congenital infection
 - Incidence of various clinical outcomes
- › Other parasites



Update

- › Kans op infectie per portie in update, top 3:
 - Schapenbout 1.1×10^{-2}
 - Theeworst 3.1×10^{-3}
 - Filet americain 4.5×10^{-4}



Filet americain

	Oud	Nieuw
Portiegrootte	39g	30g
Aantal porties (bevolking per jaar)	$1,1 \times 10^8$	$3,3 \times 10^8$
Invriezen consument	nee	3%
Invriezen producenten	0%	50%
Prevalentie rund	2%	1.6%
Parasieten concentratie	~40/g	~0,4/g
RF zouten	1	0,023

Zouten: 1,6% door het vlees gemengd bij 4°C gedurende 2 dagen