Opinion of the Scientific Panel on Biological Hazards on the "Risk assessment of a revised inspection of slaughter animals in areas with low prevalence of *Cysticercus*[1]"

(EFSA-Q-2004-017B)

Adopted on 26-27 of January 2005

SUMMARY

A number of risk factors contributing to *Taenia saginata* cysticercosis infection in veal calves have to be considered during evaluation of the risks of infection associated production. These factors can be quite variable, and also exist in different combinations, in different production systems. However, the Scientific Panel on Biological Hazards (BIOHAZ Panel) concluded that zero risk is neither achievable nor provable, especially with the present *post-mortem* inspection because of its low sensitivity in detection of the parasite's cysts. At present, due to the lack of necessary quantitative data and the low quality of the data, a quantitative risk assessment of *T. saginata* cysticercosis applicable to all different production systems existing across the EU is not achievable. Nevertheless, based on principles for a risk profile framework proposed in this document, individual veal calves production systems could be evaluated semi-quantitatively by the local competent authority, and categorised into three global groups with respect to *T. saginata* cysticercosis: i.e. high-risk, medium-risk and low-risk.

Present legislation (Directive 64/433/EEC[2]), requires visual examination and two deep incisions in external and one in internal cheek muscles parallel to mandible; the tongue having been freed to allow visual examination and palpation; visual examination of the heart, (incised lengthwise to open ventricles and to cut through intraventricular septum), and visual examination of diaphragm and oesophagus. On finding cysticerci in the

[1] For citation purposes: Opinion of the Scientific Panel on Biological Hazards on "Risk assessment of a revised inspection of slaughter animals in areas with low prevalence of *Cysticercus*" , *The EFSA Journal* (2004) 176 , 1-27

[2] OJ 121, 29.7.1964, p. 2012/64. Directive as last amended by Directive 95/23/EC (OJ L 243, 11.10.1995, p. 7).

bovine, further investigation is required. In general, the current palpation and incision techniques at routine meat inspection cannot be considered as an accurate indicator of the true occurrence of *T. saginata* cysticercosis.

Veal calves production systems should be evaluated for *T. saginata* risks at individual-farm level, at least by using a semi quantitative approach (risk profiling), and categorised in groups based on the general risk level they pose. Simplified *post-mortem* inspection, in which detection of the parasite by incision is omitted, could be applied for calves coming from integrated production systems previously assessed as of low-risk profile. Incisions of the muscles as currently prescribed in Directive 64/433/EEC[2] for *T. saginata* cysticercosis should remain an "interim" measure for calves coming from integrated production systems previously assessed as of moderate- and high-risk profile until alternative, sufficiently sensitive detection tests (e.g. Ag-ELISA-based) are developed and validated for veal calves. Therefore, such developmental and validation work should be encouraged.

Any change in production system, potentially affecting the risk level allocated to it, must result in a new risk assessment conducted in conjunction with regular or *ad hoc* re-licensing. After the detection of *T. saginata* cysticercosis in meat inspection, epidemiological studies should be carried out to determine the source of the infection in the farm and to update the farm's *T. saginata* risk profile.

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BACK GROUND

At present the Commission is revising the legislation concerning food hygiene in order to introduce modern control methods and clarify the responsibilities of the food establishment operator.

One of the proposals is the "Regulation of the European Parliament and of the Council laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption", which has obtained the political agreement of all Member States, but still awaits adoption by the European Parliament[3]. In anticipation of its adoption, implementing measures laying down specific rules for the official controls for *Trichinella* and *Cysticercus* in meat are in preparation.

In the existing legislation (Directive 64/433/EEC[4]) meat from all susceptible animals has to be examined for the presence of *Cysticercus* cysts using palpation and incision procedures. The European Commission's Scientific Committee on Veterinary Measures relating to Public Health adopted an opinion on the control of taeniosis/cysticercosis in man and animals on 27-28 September 2000[5]. In the scientific opinion a reduced examination of certain types of animals kept under specific management conditions was suggested. However, the opinion did not apply a risk assessment approach. Such an approach is presently requested by a number of Member States in order to obtain a proper quantification of the risks and the benefits involved in a reduced examination of veal calves for *Cysticercus cysts.*

Terms of reference

The European Food Safety Authority is asked to:

- assess the risks of a simplified meat inspection for the presence of *Cysticercus* cysts in calves kept under specific management conditions.

[3] EFSA's updated note: The new legislation on food hygiene has been published on the 30/04/04 (O.J. L139) and shall be applied no earlier that 1 January 2006.

[4] OJ 121, 29.7.1964, p. 2012/64. Directive as last amended by Directive 95/23/EC (OJ L 243, 11.10.1995, p. 7).

[5] Opinion of the Scientific Committee on Veterinary Measures relating to Public Health on the control of taeniosis/cysticercosis in man and animals of 27-28 September 2000, available at: http://europa.eu.int/comm/food/fs/sc/scv/outcome_en.html

ASSESSMENT

1. INTRODUCTION

This opinion presents a risk assessment on the public health implications of a simplified *post-mortem* inspection for the presence of cysticercosis in veal calves kept under specific management conditions.

The term *Cysticercus bovis* has been used previously as a name for the larval stage of the zoonotic beef tapeworm *Taenia saginata.* This has been an incorrect usage as it suggests *C. bovis* to be a separate species from *T. saginata* when in fact it is the larval form of the same parasite. Thus, for the purposes of this Opinion, the single correct name for the parasite, *T. saginata*, and the term cysticercosis for the disease caused by the larval infection of the parasite in cattle is used in keeping with internationally accepted nomenclature.

1.1. Veal calves

Various terms are used to describe different types of veal calves, these include:

- milk-fed veal for those reared on a feed program using milk-based feeds,
- grain-fed veal for those reared on a feed program using milk based feeds for the first 6 weeks and then given a whole grain-corn and protein supplemented diet.

Other terminology includes:

- "white" veal for calves slaughtered at approximately 16-19 weeks of age weighing up to 200 – 250kg.

For the purposes of this report a veal calf is an animal with an upper age limit of 7 months and up to live weight of 250 kg.

1.2. Requirements of present legislation (Directive 64/433/EEC[2]) on *post-mortem* meat inspection

- Visual examination and two deep incisions in external and one in internal cheek muscles parallel to mandible: tongue having been freed to allow visual examination and palpation.
- Visual examination of the heart, (incised lengthwise to open ventricles and to cut through intraventricular septum),
- Visual examination of diaphragm and oesophagus.

On finding cysticerci in the bovine, further investigation is required. If the infestation is generalised, the carcass and offal are rejected. However, if infestation is localised, the part of the carcass or offal affected can be rejected and the remainder kept in cold storage, not exceeding -7°C for not less than three weeks or not exceeding -10°C for not less than two weeks.

1.3. Management and husbandry systems in the EU for veal calves

There are different types of European veal production systems, for example:

a) Fully intensive units which rear batches of bought-in calves through to weaning and finish. In this system animals receive treatment in whole batches. In very intensive units, animals are killed by 200 days. Use of crates is not allowed in certain EU countries, slatted floors may be used and animals may be housed in groups.

b) Semi-intensive - smaller groups reared with later finishing targets. In this system animals are treated individually. The animals are reared inside and may suckle their mother twice a day e.g. "sous la mere".

c) Organic - when certain criteria are met (Council Regulation (EEC) No 2092/91 of 24 June 1991, last amended by Commission Regulation (EC) No 436/2001 of 3 March 2001[6]).

In relation to the rearing system of veal calves and management and husbandry systems, reference is made to the report of the Opinion of SCVPH (2003) on "the revision of meat inspection of veal calves" and to the Opinion of SCAHAW (2001) on "the welfare of cattle kept for beef production".

This opinion will only refer to calves born and bred under controlled housing conditions in integrated production systems.

Totally confined animals, however, may be infected by water or feed contaminated with human faecal matter or directly from human tapeworm carriers (e.g. farm workers) defecating in or in the vicinity of calf pens. However proglotids of *T. saginata* containing the parasite eggs are very motile and can move considerable distances so the person would not necessarily have to defecate directly in the veal calf pen but only close by for the calf to be exposed to moving tapeworm segments containing eggs.

2. HAZARD IDENTIFICATION

Taenia saginata has a two-host life cycle. Humans are the only definitive host and harbour the adult tapeworm (taeniosis), whereas cattle act as the intermediate host and harbour the larvae or cysticerci (cysticercosis). Taeniosis occurs only in the human host, after ingestion of raw or undercooked beef contained infective cysticerci. The larvae evaginate in the small intestine where they establish and become adult tapeworms; the head (scolex) attaches to the intestinal lining by way of suckers and begins forming segments (proglotids) which compose the strobila,

[6] Commission Regulation (EC) No 436/2001 of 2 March 2001 amending Annex II to Council Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. E.C.O.J.63,vol 44, 3/03/ 2001,p 16-18;

or body, of the worm. Taeniosis is characterised by mild symptoms or none at all with the adult tapeworm causing only mild inflammation at the implantation site, without substantial damage to the intestine. Patients infected with *T. saginata* often notice the proglotids as they are very motile and numerous and may pass out of the anus of their own accord. About 2-3 months after infection, gravid proglotids begin to detach from the distal end of the worm and are passed out with faeces; each segment contains about 80,000 fertile eggs. The eggs shed in human faeces can infect cattle via direct ingestion or indirectly via contamination of pasture, feeds or water. Ingested eggs result in larvae migrating to different parts of the bovine body and form cysts.

Treating people for taeniosis kills the worms but does not make the eggs present in the intestinal lumen uninfective . The treatment will cause the worm to disintegrate releasing thousands of eggs – thus when people are treated their faeces should be disposed of carefully for a period of time (48 hours) due to these "egg showers".

The occurrence of human *T. saginata* infestation in Europe has been estimated to be between <0.01% and 10%, depending on the location in Europe with areas of Slovakia and Turkey reporting the highest occurrence (Cabaret *et al.*, 2002). The occurrence of *T. saginata* cysticercosis in cattle in the EU countries varies from 0.007 to 6.8%. A summary of the occurrences of bovine cysticercosis and human taeniosis incidence in some European countries is given in Table 1.

Table 1. Occurrence of bovine cysticercosis and human taeniosis incidence in some European countries (SCVPH, 2000 - reviewed by Cabaret *et al.*, 2002).

Country	Cysticercosis[a] Prevalence (%)	Taeniosis[b] Incidence (%)	Year
Denmark	0.1-0.7	0.02	1990
Germany:			
Former East	4.5-6.8	0.33-0.62	1993
Former West	0.4-0.8	0.09	1985
Netherlands	1.8-2.2	0.14	1985
Belgium	0.03-0.2	0.26-0.46	1992
	0.0015[b]		2000
Spain	0.007-0.1	-	1999
Poland	0.24	1.64	1999
Italy	0.02-2.4	0.02-0.04	1999
France		0.11[c]	2000

[a]based on slaughterhouse data; [b]veal calves; [c]based on sales figures of specific anti-parasitic drugs to humans.

The ecological effect of *T. saginata* in beef imported from a high prevalence area into Norway was reported by Skjerve (1999). A dynamic simulation model was

used to assess the long-term effect of importing beef from an area with a high prevalence of *T. saginata* among cattle. The input of the model was from a Monte Carlo simulation model that predicted substantial increases in the prevalence of *T. saginata* in domestic cattle and in the incidence and prevalence of infections in humans that would last for more than one decade even if importation of infected beef was stopped after 2 years. The model predicted that 21 (lower 5% = 1, upper 95% = 56) viable cysts would be present in domestic prime cuts during 1996 and 1997, with 8 (0 to 21) of them being ingested without sufficient heat treatment to kill the parasite. These cysts were expected to cause 2 (0 to 7) human infections. Corresponding figures for the imported prime cuts were 1,260 (99 to 2,900) viable cysts, 462 (37 to 1,065) ingested without sufficient heat treatment, causing 132 (8 to 361) human infections. The results were strongly influenced by various assumptions about proportion of human carriers infected abroad. Only in a scenario where 99% of domestic carriers are infected abroad did the simulation results show no dramatic ecological effect of importation of the beef. If the model's predictions are realistic, then an increase in the prevalence of *T. saginata* infections in cattle would be observed in and after 1999.

2.1. Occurrences of cysticercus cysts in veal calves in the EU

In addition to the data from Zoonoses report by the Member States some other data are available from specific studies on occurrence of cysticercosis in bovines in Spain (Table 2) and in Italy (Table 3). The data in Table 2 are related to animals kept outdoor at the pasture and slaughtered in Northern Spain. The study was carried out by a particularly detailed meat inspection targeting Cysticercosis, so the results can be considered as reasonably accurate.

2.2. Sensitivity of detection in routine *post-mortem* meat inspection in detection of bovine cysticercosis.

In general, it seems that findings by the current palpation and incision techniques at routine meat inspection cannot be considered as an accurate indicator of the true occurrence of *T. saginata* cysticercosis detected by current palpation and incisions. The surface exposed by the meat inspection incisions is limited and estimated to be 2000-2500cm^2 for the masseters, 250 cm^2 for the heart (Biering-Sorensen, 1977). The authors considered that the routine incisions in the masseters reveal about 40% of the cysts and routine incision of the heart revealed only 10% of the cyst (Biering-Sorensen, 1977). In addition Geerts *et al.* (1980) detected one or more cysts in 25 hearts out of 100 hearts previously subjected to meat inspection and judged as fit for human consumption. Kyvsgaard *et al.* (1990) calculated the probability of finding at least one cyst by the standard meat inspection in animal with 'n' cysts using the formula $P = 1 - 0.96^n$.

Table 2. Occurrence of cysticercosis in cattle at slaughterhouse in Northen Spain (Garcia-Castro, 2003).

Year	Heifer/bull (10-16 month old)			Bovine> 2 years old			All animals		
	A	B	C	A	B	C	A	B	C
1992	11.665	62	0.53	378	6	1.59	12.043	68	0.56
1993	8.149	40	0.49	225	4	1.78	8.374	44	0.52
1994	4.069	17	0.42	97	0	0	4.166	17	0.41
1995	4.734	34	0.72	68	2	2.94	4.802	36	0.75
1996	5.204	23	0.44	66	4	6.06	5.270	27	0.51
1997	4.146	17	0.41	109	1	0.92	4.255	18	0.43
1998	4.286	21	0.49	93	1	1.08	4.397	22	0.50
Total	42.253	214	0.51	1.036	18	1.74	43.289	232	0.54

(A) Number of slaughtered animals. (B) Number of animals in which *T. saginata* cysticercosis was detected. (C) Percentage (%) of animals in which *T. saginata* cysticercosis was detected

On the other hand there may be differences in cysticercosis detection efficacy due to differences in the skills and motivation of meat inspectors in the speed of the slaughter line and in the meat inspection facilities. An estimate by Walther & Koske, (1980) of the sensitivity of detecting cysticerci at routine post mortem meat inspection is given in Table 4. These authors consider that in naturally infected animals the mean number of cysts by animal would be less than four.

Table 3. Occurrence of *Cysticercus bovis* in cattle slaughtered in Italy during period 1999-2000. Data from "Osservatorio epidemiologico veterinario regionale della Lombardia (http://www.oevr.org).

	Animal category	Number of slaughtered animals	Cysticercosis n°positive	% positive
Northern Italy	cow	71,131	181	0.25
	veal	30,007	52	0.17
	veal calf	32,247	17	0.05
	bull	660	1	0.15
	water buffalo	76	0	0
	total North	134,121	251	0.19
Central Italy	cow	1,077	0	0
	veal	36	0	0
	bull	10	0	0
	water buffalo	85	0	0
	total Center	1,208	0	0
Southern Italy	cow	1,379	0	0
	veal	54	0	0
	bull	18	0	0
	water buffalo	51	0	0
	total South	1,502	0	0
EU	veal	1,637	1	0.06
	total	138,468	252	0.18

Table 4. Sensitivity of routine meat inspection.

Animals with	% of animal in which cysticercus were detected by routine meat inspection
1-10 cysts	27%
11-20 cysts	42,9%
20 cysts	77,8%

Based on above assumptions, the authors calculated that the probability of cyst detection by routine meat inspection would be:

N° of cysts	Probability

1	4%
2	8%
3	12%
4	15%
5	18%

The results from a Belgian study (Dorny *et al*., 2000) indicated that *T. saginata* cysticercosis could be detected in 3.09% of slaughtered cattle using an Ag-ELISA test, whilst in only 0.26% by routine meat inspection. These results suggested that physical meat inspection could detect only a minor fraction of the carcasses actually infected with cysticerci. This opinion has also been supported by the results from studies conducted in Denmark showing that routine meat inspection is not sensitive enough to detect the light intensity infections predominantly found Danish cattle (Kyvsgaard *et al*., 1991b). Other studies have shown that in about 49-51% of lightly infected animals, cysticerci are not present in the predilection sites targeted by the meat inspection (Walther and Koske, 1980; McCool, 1979).

When considering use of blood-tests for detection of bovine cysticersosis, it can be assumed that tests based on detection of *T. saginata* antigen would be preferable over tests based on detection of *T. saginata* antibodies. The detection of antibodies cannot differentiate between previous-but-resolved exposure to, and current infection with, the parasite. Also, *T. saginata* antibodies may be detected in calves due to maternal antibodies transmission giving false positive results.

Antigen detection based tests could be used for herd surveillance as well as for individual animal surveillance, where needed. Antigen detection tests for *T. saginata* have been developed in Belgium and the UK (Brandt *et al.*, 1992; Harrison *et al.*, 1989). The specificity and sensitivity of the Belgian Ag-ELISA have been found to be 98.7 and 92.3%, respectively, when the cattle harbour more than 50 metacestodes (Kerckhoven *et al.*, 1998).

2.3. The estimation of viable eggs in the environment, slurry, on dry grass, hay and other feed

Determination of viable *T. saginata* eggs in samples of the environment, slurry, on dry grass, hay and other feed may be needed when outbreaks occur, so to determine the source(s) of infection. It may include testing of the water supplies as contaminated water was reported as the source of some outbreaks of *T. saginata* (Lees *et al.*, 2002; Kyvsgaard *et al.*, 1991a). Cabaret and colleagues (2002) reviewed the methods for detecting helminth eggs in waste water and sludge and found that most have low recovery efficiency for *Taenia* eggs ranging from 19-

48% with the triple flotation technique yielding the best results (Barbier *et al.*, 1989/ Barbier *et al.*, 1990 Faust *et al.*, 1938).

Studies in Denmark suggest that *T. saginata* eggs can remain viable in soil for about 7-8 months (Ilsoe, *et al.*, 1990; Jepsen and Roth, 1949). Jepsen and Roth (1949) demonstrated that *T. saginata* eggs were still infective to calves after storage in water for 33 days at 18°C. Hadjuk and others (1969) reported that *T. saginata* eggs can survive in river water in Germany for at least 35 days. In sewage *T. saginata* eggs remain infective to calves even after 16 – 20 days at 18°C (Hajduk *et al*., 1969; Jepsen and Roth, 1949). Whilst some reports from more than fifty year ago indicated that up to half of *T. saginata* eggs present in sewage sludge (at 24-30°C) could survive for more than 6 months, more recently has been found that the eggs can be killed in sewage sludge by some treatments such as anaerobic digestion (Pike, 1986); lime treatment (Pike, 1986); lagooning for 24 days (Pike, 1986); or aerobic digestion at 50°C for 6 days (Morris *et al.*, 1986).

T. saginata eggs may survive for 6 months under cool, moist conditions while under hot, dry conditions they may not survive more than 2 months. They have been found to survive on grass for more than 180 days (Hajduk *et al*., 1969), on hay at up to 30°C for 22 days (Lucker and Douvres, 1960) and silage at 10°C for 80 days (Enigk *et al.*, 1969).

3. HAZARD CHARACTERIZATION

3.1. Dose-response in veal calves

Since it is assumed that ingestion of a single viable *T. saginata* cyst by humans results in the infection, and in the context of this document, the main attention will be paid to dose-response in veal calves rather than in humans. The oncospheres contained in eggs passed in tapeworm proglotids and passing out with human faeces are mostly mature and readily infective to cattle. When they reach the gut of cattle certain factors such as the presence of bile salts will cause the oncospheres to be released from the eggs and activated. Within 2 hours they pass through the gut wall entering the submucosal blood and/or lymphatic vessels and migrate to the muscles where they "encyst" and become metacestodes (larvae). It usually takes about 12 days for the metacestode to become cystic with fluid formed. The scolex (head of the immature tapeworm) can be discerned at about 30 days and suckers detected at 40-50 days. The metacestode reaches its full size in 60-70 days. For every egg ingested by the cow there is a strong possibility that a cyst will form. However there is an indication that a minimal dose is needed to cause cysticercosis. Jepsen and Roth (1949) found that in previously unexposed calves 30-100 eggs developed 3-8 cysticerci, respectively, and 500 eggs produced 60-80 cysticerci.

3.2. Survival rates of cysts in muscle meat

It generally takes about 60-70 days from ingestion for the metacestodes (larvae) to become fully grown fluid-filled muscle cysts so one may be able to detect the cysts macroscopically between 1-2 months after infection. Survival time of a cyst is a

few years and then it degenerates becoming necrotic and eventually calcifies or becomes a granuloma leaving a fibrotic scar. However, in certain organ (e.g. liver, lung and heart) the cysts may degenerate as early as 20 days after infection. It is common to find living and dead cysticerci in the same bovine animal. Calves may differ from cattle in the maximal survival time of cysticerci in muscles, which may be 21-30 months, but infection of neonatal calves may result in prolonged (perhaps for the lifetime of the host) survival of cysticerci (Gemmell *et al*., 1983).

4. EXPOSURE ASSESSMENT AT PRIMARY PRODUCTION

4.1. Risk factors contributing to *T. saginata* cysticercus infection of veal calves

a) Water supply for animals

Cattle can acquire *T. saginata* cysticercosis infection through drinking water contaminated with viable eggs of the parasite. Obviously, water from open sources (e.g. rivers, lakes) which are known to receive untreated sewage discharges (possibly from multiple sources) and physically and/or chemically treated waters pose increased and decreased risks, respectively, of being contaminated with the eggs. In geographic areas exposed to flooding, even at farms normally having a good water supply, the water may become contaminated with *T. saginata* eggs from the floodwater.

b) Organic wastes as fertilisers

Sewage sludge frequently contains *T. saginata* eggs, but no accurate prevalence in a given area could be established due to both variability of control techniques and lack of data collection (Cabaret *et al.*, 2002). Nevertheless, the use of sewage sludge as fertiliser can be directly correlated to cattle infection, as demonstrated for areas having high records of cysticercosis (Engelbrecht *et al*., 1984). Farm manure used as fertiliser should not contain, by itself, the eggs, but cross-contamination with *T. saginata* eggs (e.g. water during floods, human excrements, etc) probably cannot be excluded.

c) Roughage types

Roughage, such as hay, silage, or crop by-products (e.g. potato by-products), originating from locations contaminated with human waste, can serve as sources for *T. saginata* eggs for cattle. In addition, even if not contaminated at harvesting, these feed components can become cross-contaminated later, during storage and/or distribution.

d) Farm location

As *T. saginata* proglotids are excreted in human excrements, cattle on farms near locations where high number of people with varying hygiene habits and of varying geographical origin aggregate (such as bus/railways stations) or are passing-by

(such as public countryside footpaths, train tracks) may have – directly or indirectly – a higher exposure to the infective agent.

e) Direct on-farm human excrement deposition

The most direct way of cattle infection with *T. saginata* eggs would be from excrements deposited by human *T. saginata* carriers on pasture, in or near livestock pens and/or other feeds used by the farm. It is difficult to judge whether frequencies of excrement depositing differ between outdoor (i.e. on grazing areas) and indoor depositing (i.e. in animal housing units), but it may be hypothesized that outdoor areas may be accessed by a wider range of people including "unknown", whilst indoor is accessed primarily by "known" people associated with the farm. On the other hand, due to concentration of animals, perhaps higher number of animals may be exposed to excrement from a single tapeworm carrier if they are housed indoors, rather than if kept outdoors.

f) Staff training and turnover

Farm employees that received basic public health training including awareness on the life cycle of the parasite pose less risk as a source of the cattle infection, than untrained ones. In addition, high staff turnover would represent an additional epidemiological risk and, also, may make it more difficult for the farm to maintain the needed level of training.

g) Calf age

It can be assumed that the chances of *T. saginata* cysticercosis infection increase with age of animals. The main reasons include: a) roughage feeding increases with age; b) older animals generally have had more exposure time to egg-contaminated sources.

h) *T. saginata* cysticercosis monitoring/surveillance

It is likely that good information on the real prevalence/distribution of *T. saginata* cysticercosis in cattle population, where the monitoring/surveillance system is in place, results in better epidemiological situation due to better targeted, or more thoroughly applied, control measures. The lack of such information probably increases the epidemiological risks.

i) *T. saginata* taeniasis monitoring/surveillance

It is likely that good information on the real prevalence/distribution of *T. saginata* taeniasis in the human population, where the monitoring/surveillance system is in place, results in a better epidemiological situation due to better targeted, or more thoroughly applied, control measures. The lack of such information probably increases the epidemiological risks.

4.2. Evaluation of risks associated with different veal calves production systems

To conduct a full quantitative risk assessment of *T. saginata* cysticercosis in veal calves raised in different production systems, good quality data would be needed on:

1. Prevalences of the pathogen in varying animal and human populations and related environments;

2. Quantitative parameters of environmental survival (e.g. D-values) and infectivity of *T. saginata* eggs in/on different substrates and under different physicochemical conditions;

3. The effects of the regional and seasonal variations on the data under 1. and 2.;

4. Quantitative participation (weighting) of each of the risk factors (in 4.1.) in the overall risk calculated,

5. Clear definitions and detailed process descriptions for a large number of different the types of veal calves production systems existing across the EU.

However, as most of the required data indicated above is either lacking, or is dated/insufficient quality, and also because risk factors (in 4.1.) can be represented in a large number of different combinations in a large number of different systems, the BIOHAZ Panel concluded that a quantitative exposure assessment applicable to all differing production systems is not achievable at this stage.

Nevertheless, instead, an attempt was made to develop a general framework for semi-quantitative evaluation of *T. saginata* cysticercosis risks associated with different veal calves production systems. The approach used was based on adaptation of the principles previously used in determination of microbial risk profiles of foods (CCFRA, 2000). Firstly, each risk factor enlisted in 4.1 (including its variations) was further elaborated with respect to varying scenarios posing varying levels of the risks. For a given risk factor, to each of the scenarios, a risk score (e.g. using 1-4 scale) can be arbitrarily allocated, reflecting the perceived relationship between probability of its occurrence and severity of the consequences if it occurred (a general example is shown in Table 5). Secondly, for each individual production system for veal calves, the total sum of scores given for all risk factors evaluated can determine the system's risk profile with respect to *T. saginata* cysticercosis infections. In a theoretical example shown in Table 6, three veal calves production systems, to which different scores were randomly given for the same risk factors, resulted in three different risk profiles: high-risk, medium-risk and low-risk system.

Such a global grouping was useful for the purpose of this document in order to highlight the principle and the approach how to differentiate/rank production systems with respect to risk of *T. saginata* cysticercosis in veal calves. Again, the examples of risk profiling in Table 6 should not be taken as evaluation of real-life

production systems, but as an illustration of the approach. Rather, it is believed that competent authorities and/or shareholders could use a framework, based on principles indicated here, for their own *T.saginata* cysticercosis risk profiling at individual veal calves production system level.

Table 5. Principles for semiquantitative determination of risk levels (probability versus severity scoring) for individual risk factors;

Severity of consequences*	**Probability of occurrence**				
	Frequent	**Likely**	**Occasional**	**Seldom**	**Unlikely**
Catastrophic	Very high (Score: 4)	Very high (Score: 4)	High (Score: 3)	High (Score: 3)	Medium (Score: 2)
Critical	Very high (Score: 4)	High (Score: 3)	High (Score: 3)	Medium (Score: 2)	Low (Score: 1)
Moderate	High (Score: 3)	Medium (Score: 2)	Medium (Score: 2)	Low (Score: 1)	Low (Score: 1)
Negligible	Medium (Score: 2)	Low (Score: 1)	Low (Score: 1)	Low (Score: 1)	Low (Score: 1)

* The expressions are from general risk assessment terminology, and are not meant to describe actual medical consequences of human taeniasis.

Table 6. Theoretical examples of *T. saginata* cysticercosis risk profiling of three different veal calves production systems (risk score for each individual risk factor is given randomly to the systems.

Risk factors potentially contributing to infection of calves	**Risk scoring of different related scenarios**	**Risk profiles of different veal calves production systems**

with *T. saginata* eggs		Theoretical example A	Theoretical example B	Theoretical example C
Water supply for animals potentially contaminated with *T. saginata* eggs	Score 4: Use of untreated surface (river/lake) water	4		
	Score 3: Use of untreated local water (e.g. wells)			
	Score 2: Use of treated local water		2	
	Score 1: Use of municipal water			1
Floods potentially spreading *T. saginata* eggs on the grazing and/or feed components production areas	Score 4: Regularly occurring, with waters known as receiving sewage			
	Score 3: Irregularly occurring, with waters known as receiving sewage	3		
	Score 2: Regularly or irregularly occurring with waters not receiving sewage		2	
	Score 1: No floods			1
Organic wastes potentially contaminated with *T. saginata* eggs used as fertilisers on grazing and/or feed components production areas	Score 4: Use of untreated sewage	4		
	Score 3: Use of treated sewage			
	Score 2: Use of farm manure		2	
	Score 1: No organic wastes used			1
Potential for *T. saginata* eggs contamination as related to general animal husbandry	Score 4: Animals kept mainly outdoor, grazing at multiple locations	4		
	Score 3: Animals kept combined indoor (milk-fed) and outdoor (local grazing)		3	
	Score 2: Animals kept in indoor only; milk-fed with some roughage			2
	Score 1: Animals kept in indoor only, milk-fed only			
Potential for *T. saginata* eggs contamination of roughage.	Score 4: Traceability indicates origin of roughage from high risk geographic areas"			
	Score 3: Roughage used is not traceable; multi –source and multi-component roughage	3		

	Score 2: Roughage used is traceable; multi-source and multi component roughage		2	
	Score 1: Roughage used is traceable; single-source and single- component roughage			1
Potential for exposure to *T. saginata* eggs as related to farm location	Score 4: Near camping sites	4		
	Score 3: Near bus/railway stations			
	Score 2: Near public footpaths		2	
	Score 1: Isolated			1
Potential for *T. saginata* eggs exposure as related to calf age	Score 4: >6 months	4		
	Score 3: 3-6 months		3	
	Score 1: <3 months			1
Potential for *T. saginata* eggs exposure from direct human excrement deposition	Score 4: Unknown number of people accessing grazing area			
	Score 3: Unknown number of people accessing animal housing	3		
	Score 2: Unknown number of people accessing area for feed-components production		2	
	Score 1: Little human access			1
Potential for T. saginata eggs exposure as related to staff-related aspects	Score 4: Staff not trained; high turnover			
	Score 3: Staff not trained, low turnover	3		
	Score 2: Staff trained; high turnover		2	
	Score 1: Staff trained; low turnover			1
T. saginata cysticercosis monitoring/surveillance in animals from the farm area	Score 4: No data available	4		
	Score 3: Irregular, with positive findings		3	
	Score 2: Regular, but infrequent, with positive findings			2
	Score 1: Regular, frequent, no positives			

T. saginata monitoring/surveillance in humans from the farm area	Score 4: No data available	4		
	Score 3: Irregular, with positive findings		3	
	Score 2: Regular, but infrequent, with positive findings			2
	Score 1: Regular, frequent, no positives			
		System A:	System B:	System C:
TOTAL SUM		40 (higher-risk-profile range: 32-43)	26 (medium-risk-profile range: 21-31)	14 (lower-risk-profile range: 10-20)

4.3. Risk-profiling of veal calves production systems and meat inspection

With respect to *post-mortem* inspection of veal calves for *T. saginata* cysticercosis, the Scientific Panel on Biological Hazards believes that different approaches could be used for calves originating from different production systems having different risk profiles.

The residual *T. saginata* public health risks arising from omitting the routine muscle incision/cutting procedure could be considered as negligible in calves coming from lower-risk profile systems, whilst reduced handling of their meat/organs would be beneficial from perspective of reducing the microbial cross-contamination. The lower-risk category could include slaughtered calves less than 3 months old as they are likely either not to be infected (because of diet) or if infected the cysts would not be infective by the time of slaughter. For the lower-risk calves, detailed *post-mortem* inspection for cysticercosis including tissue cutting may not be necessary (apart from visual inspection only). This would be, generally, supported by published suggestions that traditional meat inspection procedures to detect cysticercosis have negligible impact on reducing the level of public health risk in the country where *T. saginata* cysticercosis infection of cattle is low.

For veal calves coming from a medium-risk profile production system veal calf, the residual *T. saginata* public health risks arising from omitting the cutting procedure may be higher than negligible but still not very high. Still reduction of handling of meat/organs would have desirable effects on reduction of microbial cross contamination of meat. For such calves, omitting the inspection cutting procedure could still be possible, if combined with a statistically valid batch-based testing (using a validated pathogen's antigen-based blood test) of a representative number of animals before slaughter (either on-farm or during ante-mortem at abattoir) showing negative results.

For veal calves coming from a high-risk profile system, the residual *T.saginata* public health risks arising from omitting incision-based cysticercosis's inspection at *post-mortem* could be higher than acceptable, so routine physical inspection should remain until full validation of sufficiently sensitive methods for *T. saginata* antigen detection. There are indications that sensitivity of such an Ag-ELISA method (see section 2.2 above) is much higher (around 10-fold) than the meat incision-inspection method, but the sensitivity of the former may be reduced when very low number of cysts are present (Dorny, 2000). Nevertheless, the current muscle-cutting-visual-inspection procedure could be replaced by such alternative methods if proven to be sensitive enough and validated for veal calves.

4.4. How to detect increases in exposure?

The risk profile-based assessments of individual veal calves production systems should be updated regularly, periodically and when any change in the system occurs. This would allow detection of an increase in exposure if it occurs.

5. CONCLUSIONS

- A number of risk factors contributing to *T. saginata* cysticercosis infection in veal calves have to be considered during evaluation of the risks of infection associated production. These factors can be quite variable, and also exist in different combinations, in different production systems. However, it is concluded that zero risk is neither achievable nor provable, especially with the present *post-mortem* inspection because of its low sensitivity in detection of the parasite's cysts.

- At present, due to lack of necessary quantitative data and the low quality of the data, a quantitative risk assessment of *T. saginata* cysticercosis applicable to all different production systems existing across the EU is not achievable.

- Nevertheless, based on principles for a risk profile framework proposed in this document, individual veal calves production systems could be evaluated semi-quantitatively by the local competent authority, and categorised into three global groups with respect to *T. saginata* cysticercosis: i.e. high-risk, medium-risk and low-risk

- For veal calves from lower-risk production systems, including calves less than 3 months old, *post-mortem* inspection could be simplified by omitting presently mandatory incisions aimed at detection of cysticercosis, because the public health risks from associated microbial cross-contamination would exceed residual risks of not detecting the cysts due to omitting the incisions.

- For risk categories other than low-risk, traditional meat inspection would need to be maintained until sufficiently sensitive, alternative detection methods are validated for use for monitoring/surveillance and/or inspection purposes. In the latter case, the alternative method could be used either at

batch level (for medium-risk calves), or at individual animal level (for high risk calves) in combination with physical meat inspection where necessary.

- The development and implementation of alternative *T. saginata* cysticercosis detection systems in veal calves, based on evaluation of individual farms with respect to related risks and targeted use of tests (e.g. serological tests), could be beneficial for public health. It is considered that the benefits would include reduced microbial cross-contamination of the meat (via less handling) and increased detection rate of the infection (via more sensitive tests). However, there is as yet no validated serological cysticercosis test for veal calves for use in the EU.

6. RECOMMENDATIONS

- Veal calves production systems should be evaluated for *T. saginata* risks at individual-farm level, at least by using a semi quantitative approach (risk profiling), and categorised in groups based on the general risk level they pose.

- Simplified *post-mortem* inspection, in which detection of the parasite by incision is omitted, could be applied for calves coming from integrated production systems previously assessed as of low-risk profile.

- Incisions of the muscles as currently prescribed in the Directive 64/433/EEC for *T. saginata* cysticercosis should remain an "interim" measure for calves coming from integrated production systems previously assessed as of moderate- and high-risk profile until alternative, sufficiently sensitive detection tests (e.g. Ag-ELISA-based) are developed and validated for veal calves. Therefore, such developmental and validation work should be encouraged.

- Systems for monitoring and surveillance of cysticercosis are essential, both to provide necessary data for the risk assessments and to indicate the efficacy of the new system in controlling of the *T. saginata* cysticercosis and must be developed and implemented.

- Because many risk factors contributing to *T. saginata* cysticercosis infections are directly or indirectly related to people, everyone involved in the veal calves production systems should be educated on the routes of transmission and spread of the parasite and related controls.

- Any change in production system, potentially affecting the risk level allocated to it, must result in a new risk assessment conducted in conjunction with regular or *ad hoc* re-licensing.

- After the detection of *T. saginata* cysticercus in meat inspection epidemiological studies should be carried out to determine the source of the infection in the farm and to update the farm's *T. saginata* risk profile.

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SCIENTIFIC PANEL MEMBERS

Herbert Budka, Sava Buncic, Pierre Colin, John D Collins, Christian Ducrot, James Hope, Alexandre Mac Johnston, Günter Klein, Hilde Kruse, Ernst Lücker, Simone Magnino, Riitta Liisa Maijala, Antonio Martínez López, Christophe Nguyen-The, Birgit Noerrung, Servé Notermans, George-John E Nychas, Maurice Pensaert, Terence Roberts, Ivar Vågsholm, Emmanuel Vanopdenbosch.

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