

CYSTICERCUS BOVIS IN PORTUGUESE CATTLE: A TALE OF TWO ARCHIPELAGOS

BOVINELE DIN PORTUGALIA CU CYSTICERCUS BOVIS: O POVESTE A DOUĂ ARHIPELAGURI

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ABSTRACT | REZUMAT

Bovine cysticercosis is a parasitic disease caused by the young stages *Cysticercus bovis* of the tapeworm *Taenia saginata*, whose adult stages are found in humans, being a zoonotic infection. Cattle work as intermediary hosts, being humans the final hosts of this parasite. *C. bovis* is seldom diagnosed in cattle in Portugal mainland, but it has been reported frequently in recent years in Madeira archipelago.

This study focused on the detection of bovine cysticercosis in cattle born in Azores and slaughtered in Madeira Island. The study of this parasite is important not only for Food Safety and Public Health purposes, but also because of the lack of knowledge of its prevalence in the Azores Autonomous Region (AAR), namely considering that many cases of bovine cysticercosis detected in Madeira are from Azorean animals. Initially, the rejections from meat hygiene records at Autonomous Region of Madeira (ARM) slaughterhouses between 2007 and 2013 showed a total prevalence (5.82% positive), and a group prevalence of animals born in ARM (9.56% positive) and those born in Azores (5.24%). And within these, those who spent less than 6 weeks in ARM (0.8%) and those who remained more than 6 weeks in ARM (9.73%) before being moved to abattoirs had different prevalence figures. These results showed that Azorean animals slaughtered in 6 weeks after arrival were less infected than those slaughtered more than 6 weeks after arrival, or than animals born in Madeira.

Cases of bovine cysticercosis (BC) detected in Madeira in animals born in Azores and the lack of BC cases described at the AAR was the motto for the second part of this research concerning this parasite in Azores archipelago. For this purpose, 70 bulls were tested with a competition ELISA test ("Bovine Cysticercosis anti-

Cisticercoza bovină este o boală parazitologică produsă de stadiile larvare, *Cysticercus bovis*, ale cestodului *Taenia saginata* ale cărui forme adulte se găsesc la oameni, fiind astfel o infecție zoonotică. Bovinele au rol de gazdă intermediară, gazdele finale ale parazitului fiind oamenii. *C. bovis* este deseori diagnosticat la bovinele de pe teritoriul continental al Portugaliei dar a fost frecvent raportat în ultimii ani și în arhipelagul Madeira.

Acest studiu s-a bazat pe detectarea cisticercozei la bovinele provenite din Insulele Azore și sacrificate pe insula Madeira. Studiul acestui parazit este important nu doar din punctul de vedere al Siguranței Alimentare și al Sănătății Publice cât și datorită lipsei de cunoaștere a prevalenței acestuia în Regiunea Autonomă a Insulelor Azore, în special datorită faptului că multe din cazurile de cisticercoză bovină detectate în Madeira sunt regăsite la animalele provenite din regiunea Azore. Inițial, refuzurile de carne din registrele de igienă a cărnii provenite de la abatoarele din Regiunea Autonomă Madeira, din perioada 2007-2013 au relevat o prevalență totală (5.82% pozitive), un grup de prevalență la animalele crescute în Madeira și unul a celor crescute în Azore. În cadrul acestora, animalele care au stat mai puțin de 6 săptămâni în Madeira (0,8%), precum și cele care au rămas pe o perioadă mai lungă de 6 săptămâni (9,73%) înainte să fie mutate în abatoare au prezentat cifre de prevalență diferite. Aceste rezultate au relevat faptul că animalele provenite din Azore sacrificate în 6 săptămâni după ce au fost aduse au prezentat o rată mai mică de infecție decât cele sacrificate după mai mult de 6 săptămâni de la transport, sau decât cele crescute în Madeira.

Cazurile de cisticercoză bovină (CB) detectate în Madeira la animalele crescute în Azore precum și lipsa cazurilor de CB descrise în Regiunea Autonomă Azore au fost motto-ul celei de-a doua părți a acestui studiu care vizează acest parazit în zona arhipelagului Azore.

În acest scop, au fost testați 70 de tauri folosind un test ELISA (kit ELISA (GENTAUR) cu anticorpi pentru cisticercoza bovină (CYT Ab)) pentru detectarea prezenței de anticorpi de tip IgG anti-*Cysticercus bovis* înainte de transportarea lor din Praia da Vitoria, Ter-

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body (CYT Ab) ELISA kit[®] (GENTAUR)) for the presence of IgG antibodies anti-*Cysticercus bovis*, before being shipped from Praia da Vitória, Terceira (Azores) to Funchal (Madeira). From the total tested animals, 12.9% (9/70) showed high antibody concentrations (> 300 ng/ml) and from these, 44.4% (4/9) were positive to BC at Meat Inspection, whether they were soon sent to Madeira abattoirs or after some months in this island. Therefore we can conclude that animals detected with bovine cysticercosis in Madeira Island may be autochthonous, but may also acquire the infection in Azores before moving to the first archipelago prior to slaughter.

This study showed that *C. bovis* is prevalent in cattle in both archipelagos and may constitute a serious risk of infection for humans ingesting raw or undercooked meat with this parasite. Further research is needed regarding human prevalence of *T. saginata* and farms more prone to be sources of bovine infection in these islands, aiming a better Animal and Public Health status in both archipelagos.

Keywords: *Taenia saginata*, bovine cysticercosis, Madeira Archipelago, Azores Archipelago, Meat inspection, ELISA, prevalence, Public Health

ceira (Azore) la Funchal (Madeira). Din totalul animalelor testate, 12,9 % (9/70) au prezentat concentrații mari de anticorpi (>300 ng/ml) iar din acestea, 44,4% (4/9) au fost pozitive la Controlul Cărnii pentru CB, indiferent dacă acestea au fost trimise imediat la abatoarele din Madeira sau după ce au petrecut o perioadă de timp pe insulă. Astfel putem concluziona că animalele la care s-a detectat cisticercoza bovină, pe arhipelagul Madeira au fost fie de origine autohtonă, dar exista și posibilitatea dobândirii infecției pe insulele Azore înainte ca acestea să fie mutate pe primul arhipelag pentru sacrificare.

Acest studiu a demonstrat că *C. bovis* este prevalent la bovinele din ambele arhipelaguri și poate constitui un risc important de infecție pentru oamenii care ingeră carne crudă sau insuficient preparată termic care conține acest parazit. Sunt necesare studii viitoare referitoare la prevalența *T. saginata* și la fermele mai predispuse să fie surse de infecție pentru bovine, de pe teritoriul acestor insule. Acestea trebuie să țină seama obținerea unui status mai bun de sănătate publică și animală pe ambele arhipelaguri.

Cuvinte cheie: *Taenia saginata*, cisticercoza bovină, Arhipelagul Madeira, Arhipelagul Azores, inspecția cărnii, ELISA, prevalență, Sănătate Publică

Bovine cysticercosis is a parasitic infection caused by *Cysticercus bovis*, the larval stages of *Taenia saginata*. This parasite belongs to Phylum Platyhelminthes Class Cestoda, Family Taeniidae, genus *Taenia* (21).

The adult forms of *Taenia saginata* are found in the small intestine of humans. Terminal segments containing eggs are detached from the adult parasite and millions of eggs may be released daily to the environment (7). Cattle acquire the infection through the ingestion of eggs (17). The parasite migrates to highly metabolically active muscles where it develops into cysticerci and humans get infected by consuming raw or undercooked meat containing infective cysticerci, classically named as *Cysticercus bovis* (9).

The main intervention to control bovine cysticercosis in Europe, and consequently human infection, is meat inspection, followed by condemnation or freezing treatment when necessary, as prescribed by European legislation (19). However other measures such as thorough cooking of meat and the compliance with the regulations of treatment and use of wastewater and sludge are determinant to prevent parasite transmission between cattle and humans (9).

In the European Union, meat inspection is enforced through Regulation (EC) 854/2004 which prescribes a visual inspection of specific muscles and

incisions in the internal and external masseter muscles (not applicable to animals under six weeks of age) and a lengthwise incision of the heart in cattle of all ages. Carcasses and offal of heavily infected animals (generalized infections) are to be condemned. In the case of lightly infected cattle (localized infections) the affected parts are condemned and the rest of the carcass must undergo a freezing treatment that inactivates the potential remaining cysticerci (19).

Bovine cysticercosis is distributed worldwide and affects developing and industrialized countries (3).

The earliest records of *Taenia saginata* in Autonomous Region of Madeira (ARM) date back to the 1950s, in several works published by Maia (11, 12, 13, 14). During the 1980s, there were reports on the presence of this parasite in 22 of 478 children aged between 1 and 10 years of several municipalities of Madeira (1).

After the beginning of regular meat inspection in this island, achieved in 1984, it started an increase of rejected carcasses due to bovine cysticercosis in Madeira and it became clear the economic and animal and public health importance of this parasite for the region (20). The vast majority of cattle slaughtered in Madeira have external origin. The main supplier is the Autonomous Region of Azores (ARA), with much fewer animals brought from Portugal, and other E.U. countries,

such as Netherlands, Germany and France (1).

And as most of the cattle slaughtered and eaten in Madeira comes from the Azorean islands and is reared for some time at the ARM, it has been difficult so far to determine the main source of infection for these animals (2).

According to Gracey (1986) *cit. in* Santos et al. (1991), 18 weeks is the period required for the full development of cysticerci in cattle muscles, although in some cases at six weeks it is already possible a positive diagnosis at meat inspection. Based on this criterion, the infected animals from Azores staying in Madeira less than 18 weeks were considered infected at the source. This criterion for determining the origin of infection was used by Fonseca & Spínola (2000) and Afonso (2008). Having this in mind, different researchers found that 5 animals in 1990 (20), 161 between 1999 and 2000 (5) and 98 animals between 2005 and 2006 (1), were positive for bovine cysticercosis at meat inspection. These positive animals were born in the Azores archipelago and stayed less than 18 weeks in Madeira. So it was assumed they acquired the infection in the Azores islands.

However, the absence of confirmed cases of *Cysticercus bovis* in all slaughterhouses of Azores, as well the lack of information of Human cases by *Taenia saginata* in this region, made this subject one of the most controversial issues between Meat Hygiene authorities of both Autonomous Regions (2).

The aims of this paper were:

a) to study the correlation between birthplace, time of permanency in Madeira until slaughter and presence of *Cysticercus bovis* detected by meat inspection in Madeira (Study 1);

b) to detect the presence of IgG antibodies anti-*Cysticercus bovis* by an ELISA competition test in a group of 70 animals born in the Azores Island and slaughtered in Madeira, comparing those results with the time of permanency and sanitarian decision at Madeira island slaughterhouses (Study 2).

MATERIAL AND METHODS

Study 1

Data on all animal movements of cattle slaughtered in Madeira from 2007 to 2013 were obtained from Portuguese National Animal Information and Registration System (SNIRA). These results were crossed with the list of animal detected with *Cysticercus bovis* by meat inspection in Madeira for the same period of time. Data were provided by the Quality and Food

Safety Services from the Regional Directorate for Agriculture and Rural Development of Madeira.

Based on Meiry et al. (2012), we defined infected animals in Azores the ones that spent less than 6 weeks in Madeira, the minimum time for a positive diagnosis of bovine cysticercosis.

Since it was not possible to determine the degree of cysticerci cysts development, we considered all cases of bovine cysticercosis detected in animals staying more than 6 weeks in Madeira as impossible to detect their source of infection.

Data were analyzed by Microsoft Access® 2010.

The animals were divided into groups according to birth place, Madeira, Azores and external to both Portuguese Autonomous Regions. In the case of the Azorean animals, they were further divided in 2 subgroups according to time of permanency in Madeira, more and less than 6 weeks.

Differences between groups prevalence was calculated using Fisher's exact test, being statistical significant the results with $p < 0.05$. The global annual prevalence from 2007 to 2013 and the prevalence for the total slaughtered animals born in Madeira and Azores were analyzed by linear regression, calculating the R^2 to assess the correlation over the time.

All statistical analyses were performed using the program EpiTools 2014 AusVet Animal Health Services.

Study 2

A total of 70 animals born in the Azores and about to be send to Madeira were selected for blood sample collection from the tail vein, just before shipping. The search for IgG antibodies anti-*Cysticercus bovis* was performed by using blood serum samples analyzed in a competition ELISA test, "Bovine cysticercosis antibody (Ab CYT) ELISA Kit®" (GENTAUR).

Due to the impossibility of having negative and positive controls in this study, we were not able to establish a valid cut-off. The test was used only for IgG quantification while crossing the seropositive animals with the time of stay in Madeira and the meat inspection/sanitarian decision by Veterinarian Health authorities from this island.

The time in Madeira before slaughter was obtained from the SNIRA database, and the data concerning the sanitarian decision of this group of animals were provided by the Regional Directorate for Agriculture and Rural Development of Madeira's Autonomous Region. According to Gracey (1986) *cit in* Afonso (2008) and Meiry et al (2012), which refer the time from infection to onset of visible cysts to the naked eye

as 6 weeks, the animals were divided in three groups depending on the time in Madeira before slaughter: Group 1. Less than 6 weeks (N=32 bulls); Group 2. Between 6 and 18 weeks (N= 25 animals); and Group 3. More than 18 weeks (N=10 animals).

RESULTS

Study 1

According to SNIRA, 39450 cattle were slaughtered in Madeira between 2007 and 2013, of which 5533 were autochthonous, 33697 were born in Azores and 220 were from Portugal mainland and other European Union countries. Of the Azorean cattle, 16952 (50.31%) were slaughtered before 6 weeks of staying in Madeira island and the remaining 16745 (49.69%) remained more than 6 weeks until slaughter.

In this time interval, 2295 cases of animals with *Cysticercus bovis* were detected by the Veterinary Health Service inspectors, representing 5.91% of the animals slaughtered in Madeira between 2007 and 2013. Of these, 529 were born in Madeira and 1765 were from Azores, making 9.56% of the total Madeira born cattle, and 5.24% of the animals born in Azores. The prevalence of infected cattle born in Madeira (9.56%) and in Azores (5.24%), were significantly different ($P < 0.0001$) (Graph. 1).

Among animals born in Azores and slaughtered before 6 weeks of permanency in Madeira, 136 (0.8%) were positive. From the remaining animals born in Azores, with more than 6 weeks of permanency, 1929 were

positive, which is equivalent to 9.73% of this group. During this time interval, the prevalence of Bovine cysticercosis in Azorean animals slaughtered before 6 weeks of permanency in Madeira (0.8%) was significantly lower than the local Madeira cattle (9.56%) and the Azorean animals staying more than 6 weeks in Madeira archipelago (9.73%) ($p < 0.01$). There were no significant differences on cysticercosis prevalence between animals born in Madeira (9.56%) and born in Azores staying more than 6 weeks in Madeira (9.56%).

The regression analysis regarding the evolution of global prevalence of Bovine Cysticercosis (BC) in animals born in Madeira and Azores showed some interesting features. From 2007 to 2013 there was an increase in the total prevalence of cattle detected with BC in Madeira ($R^2 = 0.43$), as well as, in animals born in this autonomous region ($R^2 = 0.38$). But there was a slight decrease in positive animals from Azores slaughtered within less than 6 weeks of staying in Madeira ($R^2 = 0.24$) (Graph. 2).

Study 2

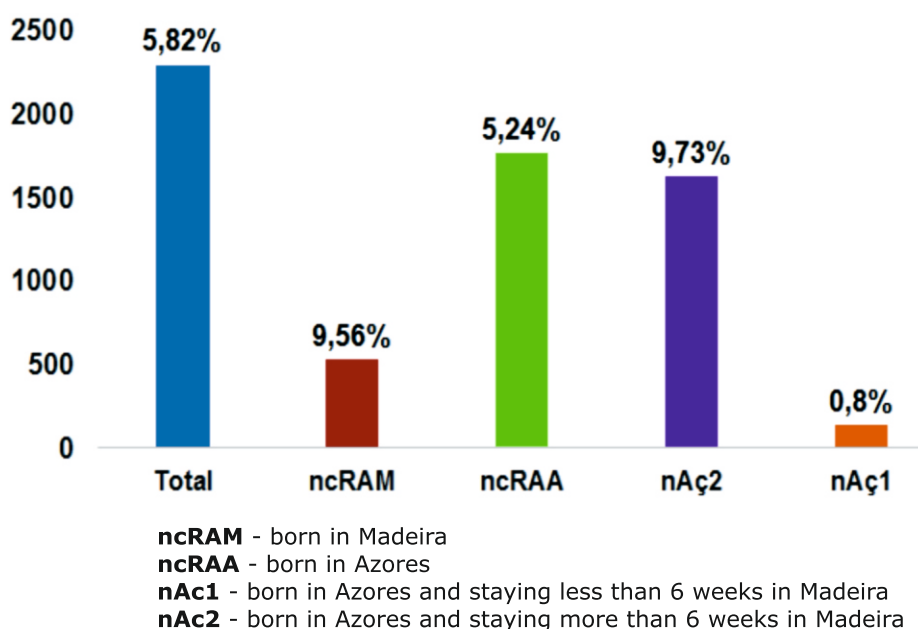
The average age of animals at shipping time from Azores (Praia da Vitória, Terceira) to Madeira (Funchal) was 20 months. And the average time of permanency in Madeira was 10 weeks. The animal staying less time on the island remained only four days, and the one with the longest period, stayed for 201 days (approximately 29 weeks). Of the 70 animals of the study, three were reported missing by SNIRA.

However, the antibody titers of these animals were 729.5, 982.5 and 15.9 ng/ml.

The remaining 67 animals were slaughtered in Madeira Island abattoir from 18 February to 3 September 2013.

From these animals, seven were detected with Bovine cysticercosis by Veterinary Health Inspectors, 10.4% of the tested animals. The 32 animals slaughtered within less than 6 weeks after the arrival, had an average age of 22 months at departure and slaughter and in this group were detected two cases of cysticercosis. The 25 animals slaughtered between 6 and 18 weeks of permanency, had an average age at boarding

Graph. 1 - Cattle detected with Bovine Cysticercosis in Madeira (2007-2013)



of 19 months and at slaughter of 23 months, being a group with 4 detected cases of cysticercosis.

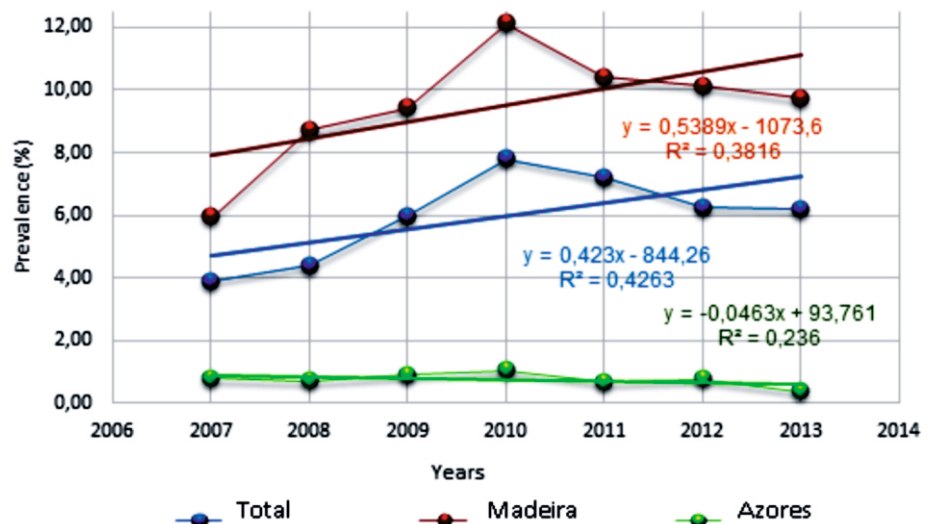
Finally, the third group, including cattle that stayed more than 18 weeks until slaughter, had the remaining 10 animals with an average age at boarding of 15 months and at slaughter of 20 months. From these animals, it was detected only one case of cysticercosis.

Of the 70 samples tested, 3 were discarded for the reasons mentioned above, while the remaining 67 samples showed IgG antibody concentrations ranging from 16.4ng/ml to 828.9ng/ml, having located the majority of animals ($n=57$) in the concentration range of 0-200 ng/ml, one animal in the range of 200-300 ng/ml and nine animals over 300 ng/ml (12.9%).

Group 1 antibody titers were lower than 200ng/ml in 29 animals, between 200-300 ng/ml for one animal and greater than 300 ng/ml for two animals (one with 473.5 ng/ml and the other with 828.9 ng/ml, the highest antibody concentration of the study). In Group 2, 19 animals showed titers less than 200 ng/ml and 6 animals a titer concentration greater than 300 ng/ml. Finally, from the 10 animals slaughtered beyond 18 weeks of arrival to Madeira archipelago, only one had a titer greater than 300 ng/ml. All remaining nine animals had titers less than 200 ng/ml.

Correlation between cysticercosis detection and antibody titers of the 67 animals used for this study showed that 7 were detected with cysticercosis at slaughterhouse meat inspection. From those, two have been slaughtered within less than 6 weeks of permanency in Madeira, 4 remained between 6-18 weeks and one had been more than 18 weeks in the region. The first two positive animals presented titers of 828.9 ng/ml and 473.5 ng/ml, and had 20 and 24 months of age, respectively. From the animals rejected at inspection in Group 2, two of them had titers greater than 300

Graph. 2 - Variation of Bovine Cysticercosis prevalence in total number of animals inspected in Madeira, and in animals born in Madeira and Azores slaughtered within less than 6 weeks of stay in Madeira - from 2007 to 2013

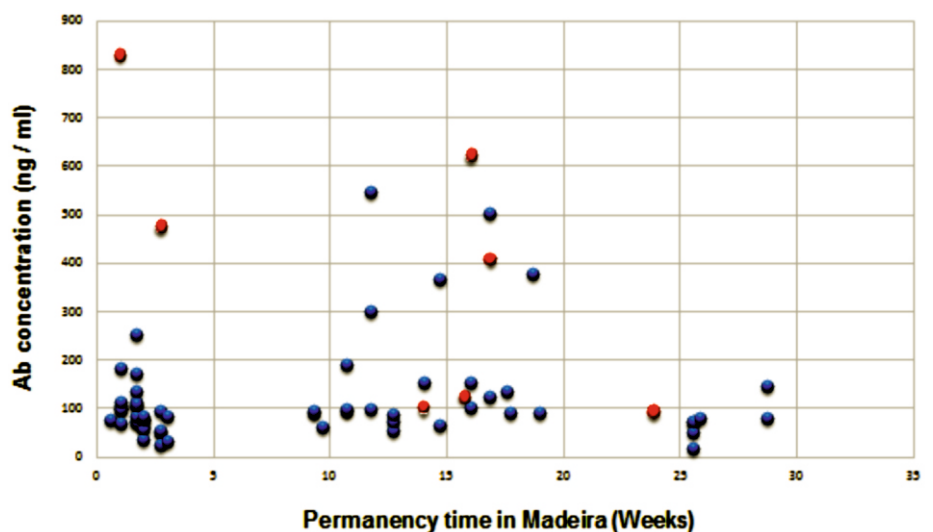


ng/ml (404.5 ng/ml and 620.4 ng/ml) and the boarding ages of 14 and 25 months. The other two positive animals had concentrations below 200 ng/ml (152.6 ng/ml and 103.2 ng/ml), with 23 to 26 months of age at shipment time, respectively. The only one rejected animal during meat inspection over 18-week of permanency in Madeira, had a titer of 91.4 ng/ml and 18 months of age at shipment time (Graph. 3).

DISCUSSIONS

Our results showed that between 2007 and 2013 there was a real increase of positive animals in Madeira to bovine cysticercosis, since the prevalence of this pa-

Graph. 3 - Antibody titers (ng/ml) of cattle born in Azores at the moment of shipping to Madeira



rasite has been steadily increasing in the last two decades, as previously described by Afonso (2008) and França Dória (2011). This global increase in total detected cases was accompanied also by a rise in cases of cysticercosis in animals born in Madeira, indicating that in the region this problem has become worst, following a trend of growing increase of prevalence as mentioned by the previous authors.

Comparing the prevalence of reported cases in Madeira born animals (9.56%), with the animals born in Azores (5.24%), a significant difference was proven according to the animal source, with an increased risk of infection for animals born in Madeira.

Nevertheless, present results confirm the presence of *C. bovis* in Azores cattle. For the Azorean animals it's extremely difficult to assess the source of infection, especially for those who stayed longer in Madeira. In this paper, a period inferior to 6 weeks was used to define the animals certainly infected in Azores, as performed by Meiry et al. (2012) to find the site of infection for cattle imported by Israel between 1973 and 2008. Therefore, the existence of Bovine cysticercosis in animals slaughtered before 6 weeks of permanency in Madeira proves unequivocally the existence of this parasite in Azores. These results confirm the findings of Santos et al. (1991), Fonseca and Spínola (2000), Afonso (2008) and França Dória (2011).

When comparing the prevalence in the Azorean animals staying less time in Madeira (0.8%), with the Azorean ones staying more than 6 weeks (9.73%) and the ones born in Madeira (9.56%), the prevalence of the first group is significantly lower than the prevalence of the other two groups. Between the animals born in Madeira (9.56%) and the ones born in Azores and slaughtered after 6 weeks of permanency in Madeira (9.73%), the prevalence of infection did not have a significant difference. This can indicate that although animals can be infected before leaving Azores, the prevalence rates in this archipelago must be significantly lower than in Madeira. Besides, after arrival, the larger the time of stay in Madeira, the greater the chance of becoming infected in this island (2).

Despite similar geo-climatic characteristics, human-animal proximity, great consumption of beef and social culture in both archipelagos, the major difference between the two regions must be the animal production/husbandry system. In Madeira, animals stay and are reared intensively in feedlots of medium to large farms and in small scale farms that are home for 1 to 5 animals, generally in areas of difficult access, with no sewage system, without sanitary facilities and

treated water for the animals (1).

On the contrary, animals raised in Azores are mainly reared in semi-extensive dairy farms and when they are in feedlots, those are not located in remote areas and have good sewage system and sanitary infrastructure (2).

This probability of having so few cases of contamination in Azores could explain the lack of detection in local abattoirs, mainly because meat inspection sensitivity has been estimated to be between 10 to 30% of the real prevalence (3, 17, 4). Therefore, in order to know better the current epidemiological context of bovine cysticercosis in Azores, the use of more sensitive surveillance strategies is needed.

The second objective of our research was to assess the existence of the parasite in Azores using a serological antibody test for its early detection.

However, the detection of antibodies against *Cysticercus bovis* is not a suitable method in order to reach a sanitarian decision in abattoirs because, as described by Lightowlers (1990), Monteiro Pinto & Dias (2006) and Paulan et al. (2013), quantification of parasite antibodies induce a large number of false negatives in naturally infected animals, compared to animals infected experimentally. It may also implies the appearance of positive animals in the test that don't exhibit infecting forms of the parasite (18), since the test does not distinguish animals harbouring cysticerci from animals exposed to eggs without establishment of cysticerci. Moreover, low levels of antibodies, antigenic cross-reactivity between parasites and shortage of parasite material as a source of antigen, may also occur in *C. bovis* cattle infection (9).

Due to the impossibility of negative and positive controls in this study, we were not able to obtain a valid cut-off to calculate a value beyond which we could be sure of a contact between parasite and host as described by Paulan et al. (2013). So, the presumption of that contact was taken from the intersection of antibody concentration and the veterinary health inspection decision, taking also into account the permanency time in Madeira.

When crossing the animals with higher antibody concentrations (greater than 400ng/ml), with Madeira Veterinary Health inspectors recorded data, we can see they had a greater possibility of contracting the infection in Azores, as long as their time in Madeira is short before being slaughtered. This fact is easy to prove for Group 1, since it had animals that were positive, some with high antibody titers and that were slaughtered before 6 weeks of permanency in Ma-

deira. All other animals slaughtered in this interval of time had concentrations below 300 ng/ml, and the majority of concentrations below 100 ng/ml. The impossibility of obtaining a reliable cut-off doesn't allow us categorically to state whether or not they had contact with the parasite in the Azores.

Of the five animals sent to abattoir after 6 weeks of permanency in Madeira and detected by the Veterinary Health inspection, two had higher antibody levels than 400ng/ml, the remaining three had relatively low levels of antibodies, below 150 ng/ml. These animals stayed in Madeira for a longer period of time, allowing development of parasite cysticerci that could be detected by Meat Inspection, even if they had acquired the infection in Madeira. However, for the animals with similar antibody concentrations to the positive animals from Group 1, they had contact with the parasitic agent in Azores and most likely they would be already infected on their arrival in Madeira. As for the animals with low antibody concentrations, below 150 ng/ml, it can be assumed that they could have acquired the infection in Madeira. There had been sufficient time for the development of parasitic cysticerci, since they were slaughtered at 14, 16 and 23 weeks after arrival to Madeira. We can't yet say with certainty that they hadn't been in contact with *T. saginata* eggs in Azores.

CONCLUSIONS

Both performed studies, based on the presence of Bovine cysticercosis in slaughtered animals before 6 weeks of permanency in Madeira and on results of ELISA test, allow us to conclude that some of the animals from Azores got the infection in the region of origin.

Azores cattle may be infected before shipping, but only few have high titers and most have low ones, possibly due to low infection density in muscle, which does not allow its visualization during meat inspection and high titers of antibodies. On the other hand, Azores cattle spending more than 6 weeks in Madeira can be infected either in the origin or in Madeira after a longer stay in this island.

Lack of knowledge of the current situation of Bovine Cysticercosis in Azores makes it necessary to further study this disease in cattle of this archipelago.

Although there are no records of Bovine cysticercosis in Azorean slaughterhouses, the potential emergence of an outbreak of this parasitic disease in the region will have a strong negative impact, not only at Public Health level, but also on the Azorean meat industry image.

The total lack of the epidemiological dimension of Azorean current situation makes urgent an epidemiological study in the region involving regional human and veterinary health authorities, to assess the real magnitude of this zoonosis in the archipelago.

The awareness of Meat Inspection teams from Azorean slaughterhouses on this subject and the standardization of *post mortem* meat inspection procedures are needed to make more effective the detection of *Cysticercus bovis* in cattle of both archipelagos.

Also, it is in the best interest of both Autonomous Regions a better mutual communication, in order to join efforts and outline strategies for the control and eradication of this problem.

Funding: Regional Board of Agriculture and Regional Veterinary Services Laboratory in Azores and Project UID /CVT /00276 /2013 CIISA - FMV - ULisboa supported by Fundação para a Ciência e a Tecnologia (FCT), Portugal.

REFERENCES

1. Afonso MBVO, (2008), Prevalência de *Taenia saginata/ Cysticercus bovis* na Região Autónoma da Madeira. Dissertação de Mestrado em Saúde Pública Veterinária, Faculdade de Medicina Veterinária, Universidade Técnica de Lisboa, 88.
2. Antunes, G.M., (2014), Parasitismo muscular em bovinos por *Sarcocystis* spp. e *Cysticercus bovis* na Região Autónoma dos Açores. Dissertação de Mestrado Integrado em Medicina veterinária, Faculdade de Medicina Veterinária, Universidade de Lisboa, 77.
3. Dorny P., Vercammen F., Brandt J., Vansteenkiste W., Berkvens D., Geerts S., (2000), Sero-epidemiological study of *Taenia saginata* cysticercosis in Belgian cattle. Vet Parasitol., 88:43–9.
4. Eichenberger R.M., Stephan R., Deplazes P., (2011) Increased sensitivity for the diagnosis of *Taenia saginata* cysticercus infection by additional heart examination compared to the EU-approved routine meat inspection. Food Control, 22:989–92.
5. Fonseca J., Spínola T., (2000), A Cisticercose Bovina identificada na Região Autónoma da Madeira Revista O Med Vet, 65.
6. França Dória J.C., (2011), A Evolução da Cisticercose na Região Autónoma da Madeira entre 2005 e 2010. http://www.vetbiblios.pt/ARTIGOS_TECNICOS/Artigos_Tecnicos.htm (accessed at 15-06-2014).

7. Geerts S., (1990), *Taenia saginata*: an eternal problem ? Verh K Acad Geneeskde Belg., 52:537-63.
8. Gracey J.F., (1986), *Meat Hygiene*. 8ª ed.: Baillière Tindall London, UK, 748.
9. Laranjo-González M., Devleesschauwer B., Gabriël S., Dorny P., Allepuz A., (2016), Epidemiology, impact and control of bovine cysticercosis in Europe: a systematic review. *Parasites & Vectors*, 9:81.
10. Lightowers M.W., (1990), Cestode infections in animals: immunological diagnosis and vaccination. *Rev Sci Tech.*, 9:463-87.
11. Maia C.C., (1949), Parasitismo humano por "*Strongyloides stercoralis*" em território português. (Notas sobre 54 casos autóctones da Metrópole). Separata do J do Med, Volume XIV 339: 91-101.
12. Maia C.C., (1950), A Distomatose hepática nos gados da Ilha da Madeira. Separatado Boletim de Informação e Publicidade, Junta dos Lacticínios da Madeira.
13. Maia C.C., (1952), Aspectos tropicais da patologia madeirense (Parasitoses intestinais: incidência e endemicidade). Separata dos Anais do Instituto de Med Trop, Volume IX, n.º 4, Dezembro.
14. Maia C.C., (1953), Sobre as parasitoses intestinais humanas da ilha da Madeira e especialmente a Ancilostomíase; Aspectos epidemiológicos, Importância económica, Medidas profiláticas. Separata do Boletim Distrital. 5, Maio, Junta, Geral do Distrito Autónomo do Funchal. Tipografia J da Madeira, Funchal.
15. Meiry M., Brenner G., Markovits A., Klement E., (2012), A Change in the Epidemiology of Bovine Cysticercosis in Israel between 1973 and 2008 due to import of live Cattle. *Transboundary and Emerging Dis*, 60: 298-302.
16. Monteiro L.L, Pinto P.S.A., Dias F.S., (2006), Evaluation of the ELISA test for the antibody detection in cattle naturally and experimentally infected with *Cysticercus bovis*. *Vet Parasitol* 141: 260-263.
17. Murrell K.D., Dorny P., Flisser A., Geerts S., Kyvsgaard N.C., McManus D.P., (2005), WHO/FAO/OIE guidelines for the surveillance, prevention and control of taeniosis/cysticercosis. Paris: OIE (World Organisation for Animal Health).
18. Paulan S.C., Gonzáles M.R.H., Peralta L.A., Vicentini-Oliveira J.C., Biondi G.F., Conde E.S., Parkhouse R.M.E., Nunes C.M., (2013), Usefulness of serological ELISA assay for *Taenia saginata* to detect naturally infected bovines *Rev Bras Parasitol Vet*, Jaboticabal. 22: 270-275.
19. Regulation (EC), (2004), No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organization of official controls on products of animal origin intended for human consumption. *Official Journal of the European Union* L139. 206-320.
20. Santos F.M.M.P., Bastos J.G., Almeida V.C.T., (1991), Contribuição ao estudo da cisticercose bovina na Região Autónoma da Madeira. *O Med Vet*, 24: 35-45.
21. Urquhart G.M, Armour J., Duncan, J.L, Dunn A.M, Jennings F.W, (1998), *Parasitologia Veterinária*. 2 ed. Rio de Janeiro: Guanabara Koogan, 106-108.