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Neospora caninum INFECTION IN CATTLE - ECONOMIC LOSS, PREVENTION AND CONTROL

Nguyen Hoai Nam[1*], Suneerat Aiumlamai[2], Aran Chanlun[2], Kwankate Kanistanon[2]

[1] *Faculty of Veterinary Medicine, Hanoi University of Agriculture, Vietnam*

[2] *Faculty of Veterinary Medicine, Khon Kaen University, Thailand*

[*] *Email: hoainam26061982@yahoo.com*

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ABSTRACT

Nespora caninum is a parasite which was first detected in Norwegian dogs and has been known as an important abortive cause of cattle. A high abortion rate up to 44% occurs in *N. caninum* positive pregnant cows.. Besides, consequence of infection could be culling of the aborted dams, reduction of milk production and weight gain, and increase of veterinary, diagnosis and replacement purchase costs. Various methods have been studied to prevent and control *N. caninum* infection in cattle. However, there are no highly effective approaches available in terms of both epidemiological and economic aspects so far.

Keywords: Cattle, control, economic loss, *Neospora caninum*, prevention.

Bệnh do *Neospora caninum* gây ra ở bò - Thiệt hại kinh tế, phòng và khống chế bệnh

TÓM TẮT

Neospora caninum là một ký sinh trùng được phát hiện đầu tiên trên chó ở Na Uy và đang được biết đến như một trong những nguyên nhân quan trọng gây xảy thai ở bò. Tỷ lệ xảy thai có thể lên đến 44%, ngoài ra hậu quả của việc bị nhiễm *N. caninum* còn có thể là sự loại thải động vật bị xảy thai, giảm sản lượng sữa, giảm tăng trọng, tăng chi phí thú y, chẩn đoán và phí mua bò thay thế. Đã có nhiều biện pháp được nghiên cứu nhằm phòng và khống chế *N. caninum* trên bò. Tuy nhiên, đến nay chưa có phương pháp nào cho hiệu quả cao, đáp ứng được cả hai phương diện dịch tễ và kinh tế.

Từ khóa: Bò, *Neospora caninum*, khống chế, phòng ngừa, tổn thất kinh tế.

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1. INTRODUCION

Neospora caninum is an obligate intracellular parasite which was detected and described in the 1980s (Bjerkas et al., 1984; Dubey et al., 1988). Infection of *N. caninum* has been reported worldwide in a variety of animals in which cattle is the most affected livestock so far. *N. caninum* causes abortion in cattle mostly at 5th to 7th month of gestation, and a very high percentage of the pregnancies could be lost in the positive cattle (Huang et al., 2004; Lopez-Gatius et al., 2004). Therefore, it has been recognized as one of the most important bovine abortive pathogens. This review focuses on *N. caninum* infection in terms of ecnomic loss and measures applied to prevent and control neosporosis in cattle.

2. ECONOMIC LOSS IN CATTLE RAISING INDUSTRY INCURRED BY *N. CANINUM*

The economic loss due to *N. caninum* has been reported mostly in cattle despite the facts that neosporosis is also found in several other domestic and wild animals. The direct damage is fetal loss beside the indirect loss including cost of reduced milk production, culling and replacement, low weight gain, veterinary cost, rebreeding and diagnosis.

Abortion is the most significant loss caused by neosporosis (Pabon et al., 2007). Seropositive cows may have up to 23.6 times higher risk of abortion than seronegative counterparts (Weston et al., 2005). Proportion of pregnancy loss could be up to 44% due to *N. caninum* infection (Lopez-Gatius et al., 2004). When abortions occur either in sporadic or epidemic type, the initial veterinary investigation causes NZ$400 for each case (Reichel and Ellis, 2006). In the Netherlands, 76% seropositive farms without abortions do not endure reduction of revenue due to neosporosis. By contrast, 24% remaining farms in which the abortions occurred may lose up to €2,000/farm/per year (Barling et al., 2000).

There is an association between serostatus and reduced milk production in highly frequent aborted herds (Hobson et al., 2002). Several authors have demonstrated that milk production and milk quality in the positive cattle are lower than those in their negative counterparts. Lower milk and fat production of 3.1 lb/cow/day and 0.14 lb/cow/day were reported (Thurmond and Hietala, 1997). Each positive cow may produce 3-4% milk less than negative cow, and the cost due to neosporosis is $128/cow/lactation (Hernandez et al., 2001). Milk, fat and protein yield declined by 158 kg, 5.5 kg and 3.3 kg each lactation, respectively (Tiwari et al., 2007).

Neosporosis can cause economic loss due to the increase in number of services per conception in positive cows (Hall et al., 2005). Also, in that study day open had a trend to be longer in the seropositive cows than their negative counterparts. Chances of a positive heifer not to conceive is 1.8 times higher than those of negative heifers (Munoz-Zanzi et al., 2004).

The risk of being culled is also higher, i.e 1.6 times to 1.9 times, in the positive cattle (Bartels et al., 2006; Thurmond and Hietala, 1996; Tiwari et al., 2005; Waldner et al., 1998). In the high serostatus herds, the culling risk is 1.73 times higher than in the herds with low serostatus or free of neosporosis (Bartels et al., 2006). Once the aborted cattle are culled, farmers may purchase new cows as replacement which approximately costs NZ$ 1,400 for each (Deverson, 2005).

N. caninum infection also detrimentally affects the ability of food digestion in beef catlle which results in low average daily weight gain, live body weight at slaughter and hot carcass weight. In each case of reduced post-weaning weight gain due to *N. caniunm* infection, the owner looses $ 15.62 (Barling et al., 2000).

There is a substantial expense in vaccination against, diagnosis and treatment of neosporosis. There used to be a commercial vaccine against *N. caninum* infection in cattle. This Bovilis-Neoguard vaccine used to be sold at price of 3.5 USD per dose in America. The vaccination appears to be reasonably expensive and labour-intensive, requires two vaccinations per annum initially and each year thereafter (Reichel and Ellis, 2006). The diagnosis fee is also considerably expensive. An epidemiological survey or a test for culling are most likeky to use a serological approach which is about NZ$ 10 for one cow (Reichel and Ellis, 2006). In the case of treatment, BayCox (toltrazuril-sulfone) is reported to be one of highly efficacious drugs for experimental *N. caninum* infection. This therapy takes 6 days to complete and costs NZ$ 568.8/cow (Kritzner et al., 2002). Assuming that this treatment can be applicable to the natural infected cattle. For a herd of 100 cows and the prevalence is 10%, so the economic loss associated treatment is around NZ$ 5688. However, this is not enough to ensure that the infection does disappear from the herd in the future.

In Switzerland, the annual loss in dairy industry induced by neosporosis is estimated to be € 9.7 million in total. In detail, farmers loose € 1.9-2,0 million, € 0.123-0.160 million, € 5.9 million and € 1.6 million due to abortion, cost of veterinary service, reduced milk yield and premature culling, respectively (Hasler et al., 2006). In California where there are about 40,000 abortions due to neosporosis annually, the economic shortfall is measured approximately $35 million (Barr, 1998). In Australia and New Zealand, the deficit incurred by neosporosis is considered up to 100 million Australian dollars per year (Reichel, 2000). Each 50-dairy cow herd in Canada looses 2,304 Euros every year (Chi et al., 2002).

The loss predisposed by neosporosis in the cattle industry is really substantially significant. *N. caninum* has been reported worldwide but the economic damage has been estimated in only a few countries. It should be born in mind that the real loss caused by neosporosis in the cattle production should be much higher than those have been demonstrated.

3. PREVENTION AND CONTROL OF *N. CANINUM* INFECTION IN CATTLE

Prevention and control of neosporosis base on the reduction of number of positive animals in the herds by decreasing the risk of both vertical and horizontal transmission. Quite several approaches have been proposed including "testing and culling", improvement of the bio-security of the farms, reproductive management, chemotherapy and vaccination.

Testing the whole herd and culling all the positive animals are considered the most effective measure to eradicate neosporosis. However, this solution is criticized for its economic impacts, and this may result in the change of gene system, structure of the herds and its effects on the stabilization of the meat market (Hasler et al., 2006; Larson et al., 2004). Culling female that fails to give birth to a calf is also suggested, however, this is not specific because there are several causes of the failure of a pregnancy carriage beside neosporosis. In the effort of eradication of neosporosis from cattle herds, selling seropositive female and purchasing seronegative replacement female is considered to be epidemiologically effective but it is not likely to be economically beneficial. Alternatively, the policy of discontinuing breeding the offspring of the positive dams seems to be the suitable choice for its advantages in the aspect of economics though the efficiency in the epidemiological respect is lower than the former measures (Larson et al., 2004).

There are no available clues about the existence of horizontal transmission between intermediate hosts, and only vertical transmission in intermediate hosts can not guarantee the survival of the parasite infection. Therefore, neosporosis will not be able to survive if there is no horizontal transmission between definitive and intermediate hosts. Presence of dogs in farms positively associated with the prevalence of the infection (Corbellini et al., 2006), seroconversion of the cattle (Dijkstra et al., 2002) and storm abortion within herds (McAllister et al., 2000). Those findings suggest that it is sensible and plausible to restrict contact between dogs (and other definitive hosts) and cattle to reduce the transmission and prevalence of the infection as well. Aborted fetuses and placenta, infected tissues from calves and cows should not be within the access of the definitive hosts. Food and water provided to cattle should be covered and protected from the infection of oocysts. Since several rodents such as mice, rats and rabbits were infected with *N. caninum,* farms of animals should be free of these rodents so that definitive hosts will not get infected by eating them and transmit disease to the cattle (Hughes et al., 2008). A similar policy should be applied to poultry since chickens and pigeons are possible intermediate hosts of the parasite (Costa et al., 2008; Mineo et al., 2009).

Some reproductive resolutions have been suggested to prevent and control neosporosis. The use of beef bull semen to inseminate dairy cows could reduce the risk of abortion (Almeria et al., 2009). In this study, seropositive Holstein-Friesian dairy cows were inseminated with semen of Holstein-Friesian and beef cattle breed, viz Limousion, Charolais, Piedmontese or Belgian Blue cattle. The results showed that abortion rate in dairy cows inseminated with beef bull semen was significantly lower than that in the dairy cows inseminated with dairy bull semen. Among of all groups, proportion of fetal loss is lowest in the crossbreed pregnancies between Limousin and Holstein-Friesian compared to other groups. However, in the aspect of epidemiology, this is not a prudent choice because it can not reduce the vertical transmission. Moreover, most of the calves born from those positive cows are transplacentally infected and they will become the source of infection. Based on the fact that early cattle embryos did not expose to the parasites (Moskwa et al., 2008), embryo transfer using the positive elite donors and negative receivers could be a better option (Landmann et al., 2002). Nevertheless, this approach is rather limited because of the restriction of embryo transfer.

Currently, little information about chemotherapy for treatment of neosporosis in cattle is available. Most studies are conducted in-vitro and in mice models. Some drugs such as toltrazuril and its derivative named ponazuril, and thiazolide are experimentally used in vitro and are described as auspicious medication (Esposito et al., 2007a; Esposito et al., 2007b; Muller et al., 2008). However, more studies are required to confirm their anti-N. caninum ability and their in vivo application. In mice model, toltrazuril is found to reduce fetal loss and diaplacental passage of the parasites to the fetal brain (Gottstein et al., 2005). Those authors also reported that toltrazuril and ponazuril could completely prevent the formation of cerebral lesions in the experimentally infected mice (Gottstein et al., 2001). Toltrazuril can also increase the rate of survival of congenitally infected mice (Strohbusch et al., 2009). In newborn calf model, toltrazuril is demonstrated to possess the potential to eliminate N. caninum (Haerdi et al., 2006). In another study, ponazuril (tultrazuril sulfone) is able to protect experimental N. caninum infection calves (Kritzner et al., 2002). According to this study, all of 11 experimentally infected, treated calves were negative in PCR test. This confers a very high rate of successful cure. However, the number of the experimented animals is too restricted and it does not match the statistical requirements. Furthermore, in this research, the calves were treated at 6 hours after the oral infection which could not be performed in the naturally infected cattle. It is still not known that if this drug can cure the cattle in which the infection has been already existed. Therefore, the treatment efficacy of tultrazuril sulfone is demanded to show in the naturally infected cattle.

Protection of animals from neosporosis by vaccination is now still facing difficulties since there are no highly efficacious proven vaccines though several types have been studied. Recombinant vaccines are used in mice and show controversial effects on prevention of infection (Aguado-Martinez et al., 2009; Debache et al., 2009). In the former study, negligible protection of the vaccination on hebdomadal and neonatal mortality rates of pups were observed. However, the latter study found that the vaccination could significantly protect against vertical transmission. Similarly, a surface protein vaccine is also reported to be able to induce protection against N. caninum congenital infection in mice (Haldorson et al., 2005). Similarly, in a study using gamma irradiated tachyzoite as the vaccine, all the vaccinated mice are healthy and survive after day 25 post-challenge while the whole group of unvaccinated mice die within a week (Ramamoorthy et al., 2006). However, it is demanded to be studied to confirm those vaccines' capability and be applied in cattle. Recently, a DNA vaccine has been studied but it is still in the beginning of the story since only the aspect of immune response is documented (Zhao et al., 2009). In sheep, a killed tachyzoite vaccine succeeds in improving fetal survival but fails to reduce congenital infection (Jenkins et al., 2004). Auspiciously, a live tachyzoite vaccine is also found to confer protection against fetal death in cattle (6/6 fetuses) while whole lysate tachyzoite vaccine fails (1/11 fetuses) (Williams et al., 2007). So far, there used to be only one commercial killed whole tachyzoite vaccine named Bovilis Neoguard, nevertheless it fails to confer a stable efficacy to protect cattle from abortion since its efficiency varies from 0% to 54% (Heuer, 2003; Romero et al., 2004).

All the methods to prevent and control *N. caninum* infection in cattle mentioned above have showed their advantages and disadvantages. “Testing and culling” seems to reach the optimal epidemiological target but the downside is the extreme cost and it may cause the instability in herds. Biosecurity is cheap but, to some lesser extents, passive, so can not be a definitive approach. Reproductive resolutions may not be applied in a large scale due to the restriction of embryo transfer. So far, there are no approved commercial drugs and vaccines widely used to treat or prevent neosporosis in cattle.

4. CONLUSION

N. caninum infection is reported all over the world as one of the most important cause of bovine abortion, and predisposes substantial loss to the cattle industry. Many measures have been used to prevent and control *N. caninum* infection in cattle. However, no approaches are approved to be a highly successful tool. Chemotherapy and vaccination could be primary methods in the battle against this parasite. Therefore, future studies are demanded to find out highly efficacious and inexpensive drugs and vaccines.

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