Review Article

THE OCCURRENCE AND SURVIVAL OF PARASITIC CAUSATIVE AGENTS IN SLURRY

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Abstract

Animal faeces are considered an important non-living vector of transmission of various infectious agents since they contain a broad spectrum of microorganisms. The floor of rearing facilities is a reservoir of infectious agents for kept animals. For this reason the slurry should be considered as infective in the case of an outbreak of any infectious disease.

Parasitic infections are spread with slurry that normally occur on farms and enter the process of infection only through animal faces.

From the aspect of environment protection from dangerous infections it is to keep in mind that the time and temperatures for anaerobic stabilization of slurry should be observed. These parameters must ensure reliable liquidation of all pathogenic germs. It is a well-known fact that the temperature and time of exposure of treated slurry have a direct influence on pathogen devitalization.

The resultant substrate, which will undergo the process of composting when temperatures around 70 ºC are reached, the composted heap is continually turned over after several days and possibly ground limestone is added (but it is not a condition), can be used for bedding in any animal species and category without fear of an outbreak of parasitic infection.

Key words: parasites, waste water, faeces, animal hygiene

INTRODUCTION

Parasitoses belong to the most widespread infectious diseases occurring on farms in Czech Republic. The parasites do not usually cause any deaths and severe clinical diseases but they influence efficiency parameters in all categories of farm animals when lower nutrient conversion resulting in weight loss and growth retardation is mostly their consequence. Other great losses are incurred at slaughterhouses due to the confiscation of internal organs (Roepstorff et al.,1998; Nansen and Roepstorff, 1999; Permin et al., 1999; Joachim et al., 2001; Weng et al., 2005). Often the presence of parasites in the animal's body is the entrance gate for infectious agents of bacterial and viral origin (Ryšavý et al.,1988; Koudela, 2000b).

In technological systems of farms in mild climatic zone animals are often kept permanently in closed barns that become their lifetime space. Animal hygiene in breeding and preventive measures, which can prevent greater economic losses, have a crucial impact on the spread of parasites on farms. An overview of the prevalence and control of animal parasites is a significant prerequisite for efficient animal husbandry especially in closed facilities (Nápravník and Zajíček, 1993).

Resistance of parasites to external environmental conditions

The conditions influencing the prevalence, survival and spread of parasites are determined by abiotic and biotic factors (Anderson and Sukhdeo, 2010). Abiotic factors are of physical and chemical nature; biotic factors are e.g. food supplies, competition and relationships between the host and the parasite (Ibrahim, 2010). A complex of abiotic factors is decisive whether the parasites concerned can or cannot live in the given environment; biotic factors are of crucial importance for determination of the relative frequency of the parasite in question.

Protozoan parasites

Especially coccidia (eimeria, cryptosporidia, isospores etc.) and giardia (flagellates) belong to the most frequent protozoan parasites in farm animals in conditions of this country. The symptoms of acute coccidiosis differ according to the types of coccidia causing this disease and according to the animal species hosting it. A common symptom is diarrhoea accompanied by loss of appetite, general emaciation and a number of patho-physiological changes (Gdovin et al., 1970; Ryšavý et al., 1988). Animals suffer from watery, mucoid or bloody diarrhoea, often very fetid and foamy. This state may lead to the overall poor body development after weaning (Dražan et al., 1987; Nápravník and Zajíček, 1993). If the animal survives the infection, it will be resistant to a new infection by the same species.

Coccidia of the genus Eimeria, which occur on farms most frequently, are strictly host specific, it means that one animal species will not be infected by oocysts from the animal of another species; tissue specificity is also high (Gdovin et al., 1970; Ryšavý et al., 1988). Depending on infection severity the animals may die (up to 50% mortality).

Cryptosporidia are parasites that infect epithelial cells of the digestive tract of many vertebrate hosts including humans. Unlike the majority of the other species of coccidia they are characterized by low host specificity and, in addition, they are excreted from the body of the infected animal as sporulated, i.e. infective. Water (drinking, recreational and sea water) and foods contaminated by oocysts from humans and animals have been confirmed as sources of infection.

Cryptosporidiosis is described as a zoonotic disease and the most widespread species is *Cryptosporidium parvum* (Pavlásek, 1995; Quílez et al., 1996; Fayer et al., 1997; Koudela, 2000a; Dillingham et al., 2002; Guselle et al., 2003; Fayer et al., 2004, Ben-Ami an Regoes et al., 2008, Thieltges and Jensen et al., 2008). An important health problem is that cryptosporidia are resistant to current disinfectants used for treatment of drinking water and they are a frequent and serious complication in individuals suffering from immunodeficiency (O'Donoghue, 1995; Fayer et al., 1997; Dillingham et al., 2002; Thompson and Chalmers, 2002). Cryptosporidia are one of the many parasites for which no medical treatment has been discovered as yet (Thompson and Chalmers, 2002, Finstein, 2004).

Climatic factors such as temperature, humidity and oxygen content can have a great influence both on the viability and persistence of unsporulated and sporulated oocysts in the environment and on the course of sporulation. Unsporulated oocysts were proved to be much more sensitive to changes in the ambient environment (temperature, humidity etc.). The temperature of 28–31 °C is the most favourable for sporulation. Oocysts are much more sensitive to elevated temperatures. Temperatures above +35 °C have a reducing or inhibitory effect on oocyst development (Lasen and Viltrop et al., 2009).

Oocysts are known to be less resistant to dessication and warm conditions (Lindsay and Blagburn, 1991). Oocysts may be inactivated efficiently at temperatures of 54–55 °C within 30 min. (de Regnier et al., 1989; Whitmore and Robertson, 1995). De Bertoldi et al. (1983) reported that oocysts were inactivated after 30 minutes if the temperature of 70 °C was reached during composting. Continuous turning of a composted heap and temperature measurement are important for oocyst inactivation. The other available literature sources cite various temperatures and times necessary for the inactivation of infectious oocysts in water but all agree that temperatures around 60 °C have a lethal effect within 5 minutes and temperatures around 70 °C are devitalizing within several seconds (O'Donoghue, 1995; Fayer et al., 2000; Dillingham et al., 2002; Fayer, 2004; Gajadhar and Allen, 2004; Rimhanen-Finne et al., 2004; Dawson, 2005).

Koudela (2000b) reported that oocysts of coccidia did not survive the temperatures below –30 °C and above +40 °C for a long time. Within this temperature range they can survive for more than a year. Oocysts of coccidia are devitalized only by ammonia-based disinfectants and hot steam. Long et al. (1982) stated that during poultry dung storage that was accompanied by self-heating the temperature around 63 °C was lethal for all oocysts. The value of relative humidity (rH) is very important because oocysts are sensitive to dissication (Daugschies, 2000). Oxygen deficit is also limiting for the successful development of oocysts. Oocysts are damaged by direct solar radiation. Long et al. (1982) described that the unsporulated oocysts of the coccidium *Eimeria zürnii*, which belongs to the most pathogenic coccidia in cattle, survived for about 4 hours in direct sunshine compared to sporulated oocysts that may remain viable up to 8 hours. Formalin, gaseous or aqueous solution of ammonia and methyl bromide are the most efficient chemical protection. The application of hot steam is also a very efficient physical method (Long et al., 1982; Mehlhorn et al., 1993; Nápravník and Zajíček, 1993; Chroust, 1998; Daugschies, 2000).

The flagellate of the genus Giardia is another protozoan parasite spread all around the world. Giardia is a very successful parasite in its evolution, relationship to the external environment and it has unusual physiological plasticity and adaptation ability to changing internal and external conditions (Fayer, 2004; Gajdhar and Allen, 2004; Graczyk, 2005). Diarrhoea caused by giardiosis can debilitate the afflicted animals for several weeks or months, being manifested by symptoms of alternate intensity. Similar to cryptosporidiosis, giardiasis is an opportune infection, i.e. as a secondary disease it accompanies a primary viral, bacterial or parasitic disease (Chroust et al., 1998; Juránková, 2001).

Cysts of giardia are highly resistant, surviving in water and in soil for several weeks; similar to oocysts of cryptosporidia they are not devitalized by current disinfectants (Gibson et al., 1998; Betancourt and Rose, 2004). If giardiosis has been introduced onto a farm, all animals should be treated. Development of the infection is undoubtedly influenced by nutrition. Protein food suppresses the propagation of giardia while it is stimulated by saccharide food. The intake of mother's milk substantially contributes to the protection of the young (Chroust et al., 1998; Juránková, 2001).

The survival of cysts in external conditions is similar to that of cryptosporidia. At temperatures around the freezing point they can survive approximately for two months, at –18 °C they die within an hour and temperatures around +70 °C destroy them almost instantaneously. UV radiation is supposed to be highly efficient. Ozonizing and high-quality filters are very efficient in water treatment (Deng and Cliver, 1992; Rimhanen-Finne et al., 2004; Dawson, 2005). The same conditions as in coccidia are applicable in composting (Rimhanen-Finne et al., 2004).

The environment of barns is ideal for oocyst and cyst sporulation, creating very good conditions for the origination and rapid spread of infections. Eradication of these parasites by means of common disinfectants at recommended doses is mostly not efficient. The viability of oocysts and cysts is reduced or totally liquidated only by complete dissication and by the effect of high temperatures. The application of hot water is recommended for sanitation after thorough mechanical cleaning and flushing of rooms with pressure water (Nápravník and Zajíček, 1993; Lukešová et al., 1997).

Parasitic helminths

Some species of helminths play a different role in infections, which underlies importance. Concrete losses are incurred by the confiscation of liver, lungs and other organs and their trimmings due to their infestation by parasites (France, 1995; Joachim et al., 1999; Epe, 2002; Resch, 2002; Vergara and Otto, 2002).

Thanks to their resistance, eggs of parasites may be viable for 6 to 10 years under favourable conditions (Straw, 1991; Corwin and Tubbs, 1993; Koudela, 2000b; Lehmann, 2000; Meyer and Schulze-Horsel, 2000b; Rommel et al., 2000; Koudela and Russ, 2002). Helminth eggs are sensitive to direct solar radiation, elevated temperatures and they are dissication-sensitive (Sprehn, 1957; Nápravník and Zajíček, 1993; Roepstorff and Nansen, 1994; Larsen and Roepstorff, 1999; Lehmann, 2000; Rommel et al., 2000). Gaasenbeek and Borgsteede (1998) observed that the eggs in slurry that was at a dry and sunny place survived for 2–4 weeks only a moist and shady place 90% of eggs were whereas capable of further development after eight weeks.

For example eggs of nematode worms of the genus Ascaris (roundworms) belong to the most resistant on ones. Many papers focused on devitalization of these resistant developmental stages. The majority of these papers reported that the survival was prolonged at increasing rH (Jurášek et al., 1993; Nápravník and Zajíček, 1993; Roepstorff and Nansen, 1994; Lukešová et al., 1997; Gaasenbeek and Borgsteede, 1998; Chroust, 1998; Larsen and Roepstorff, 1999; Daugschies, 2000; Hausmann and Hülsmann, 2003).

Temperature is another, not less important factor. Eggs may survive in slurry for more than 3 months at temperatures of 10–17 °C. Putrefactive bacteria and reduced oxygen supply participate in the process of devitalization. Cherepanov et al. (1977, in: Zajíček et al., 1980) tested the efficiency of thermal dehelminthization of liquid manure of pigs and cattle in a facility where it was heated up to 51–56 °C under continuous agitation and they reported the devitalization of all parasitic germs within three hours. Similar results were obtained by Plym-Forshell (1995) when no viable eggs were found in 24 hours in slurry stored in a tank at a temperature of 55 °C. Nápravník and Zajíček (1993) reported that eggs died in 8–10 minutes at 50–55 °C, in 5 minutes at 60 °C and in 1 second at 70 °C. Similar datas were also reported by Zavadil (1960) and Lukešová and Žižlavský et al. (1997).

In general, the larvae survive in humid conditions for a longer time while they can resist to dry conditions only for hours or days, in relation to ambient conditions (Jurášek et al., 1993; Nansen and Roepstorff, 1999). It is to summarize that sunrays, heat, desiccation and oxygen deficit lead to the liquidation of eggs and larvae. Hot solutions of at least 5% lye impair the lipoid layer of the egg envelope and a high temperature above 50 °C destroys the germ in the egg envelope at the same time (Lukešová and Žižlavský et al., 1997; Koudela and Russ, 2002). The parasites are not destroyed by lower temperatures and humidity but their development is prolonged (Larsen and Roepstorff, 1999; Kraglund et al., 2001; Meyer and Schulze-Horsel, 2000a).

Destruction of parasitic germs in faeces

It is to note that devitalization efficiency of slurry is applicable mainly during long-time storage (Bornay-Llinares et al., 2006; Heinonen-Tanski et al,. 2006). Because fresh slurry is permanently mixed with stored slurry in pits, its devitalization potential is changing. It was found that in deep litter parasitic germs were safely devitalized in layers deeper than 10 cm but layers within a depth of 10 cm provided an optimum environment for their development.

On most farms pits are built for the collection of liquid manure. On large fattening farms pits are usually unloaded after 2–3 months but from the aspect of sanitation the most suitable are pits allowing the liquid manure storage for 6 months because oocysts of coccidia and eggs of helminths in faeces die within 2–2.5 months at the earliest in the summer season; this time is prolonged at a lower temperature.

It is recommended to perform sanitary measures such as: composting when biological sterilization occurs due to self-heating, aerobic thermophilic sterilization of faeces by means of microorganisms when slurry is exposed to a temperature of 50–60 °C for 5–7 days, application of slurry to fields where their subsequent cultivation is envisaged (ploughing, sowing) and complex microbiological treatment of liquid manure.

The use of some disinfectants or the use of antibiotics negatively influences the course of biological sterilization of slurry. Biological sterilization should be controlled by temperature measurements, establishment of coprocultures or evaluation of the morphological development of germs (sporulation, cleavage) to demonstrate an active course.

Hygienic measures and prevention of parasitosis

The aim of hygienic measures is to interrupt developmental cycles of parasites in the environment where farm animals are kept and to prevent infections in animals of all age categories. The elementary condition is to maintain perfect cleanness in barns by mechanical disposal of faeces, regular pressure washing of pen floors, walls, alleys, platforms and equipment. Simultaneously, mechanical cleaning is followed by thorough disinfection of all the above-mentioned spaces and equipment with water much warmer than 80 °C or steam. If an aqueous solution of disinfectants is used for disinfection, it must be heated to 60 ºC at least. These measures are taken whenever the animals vacate the barn or its section and the treated surfaces are let dry thoroughly by ventilation (Chroustová, 1979; Corwin and Tubbs, 1993; Nápravník and Zajíček, 1993; Roepstorff and Nansen, 1994; Chroust, 1998; Meyer and Schulze-Horsel, 2000a; Pollmeier, 2000; Joachim et al., 2001a; Epe, 2002; Lahrmann et al., 2002; Resch, 2002; Vergara and Otto, 2002).

The runs for animals should be kept clean and regular disposal of faeces must be carried out. The animals of different age categories should not be rotated in runs in any case. In litter housing clean straw is distributed every day after the preceding mechanical cleaning of pens. E.g. before late-pregnant sows are moved to a farrowing house or possibly before expected farrowing they are washed with warm water (about 40ºC) and before the first sucking of piglets the mammary glands are washed with soap and lukewarm water and all impurities are safely removed. The all-in and all-out system is recommended (Hennessy, 1997; Heinonen-Tanski et al., 2006; Behal, 2006; Smith et al., 2009).

From the aspect of veterinary prevention it is important to monitor the health status of animals, to take faecal samples at regular intervals and to examine than. It is also necessary to perform the consistent veterinary inspection of newly housed and/or bought animals and, last but not least, timely and repeated treatment (Boes et al., 2005) with efficient antiparasitics should be done (Cernanska et al., 2008).

Some experimental studies demonstrated that the application of anthelmintics in the form of injections (Praslicka et al., 1999) was much more efficient than the administration of the product in feed or water. It is to emphasize that not only anthelmintics but also the other antiparasitics should not be used routinely but the treatment should be connected with the other tending measures in relation to the husbandry system in order to reach an optimum effect and to avoid development of resistance, i.e. the application of medications should be performed on the basis of the regular parasitological examination of kept animals (Varady and Čorba et al., 2009). Along with these steps it is necessary to ensure good nutrition, beginning with the newborn. Emphasis is laid on the sufficient intake of colostrum and milk, to supply immunoglobulins in the first weeks of life.

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