Measures against exo- and endogenous stages of pig coccidia in industrial farms

R T Safiullin¹ and D P Skachkov

All-Russian Scientific Research Institute of Fundamental and Applied Parasitology of Animals and Plants (ARSRIP) - branch of the Federal State Budget Scientific Institution «Federal Scientific Center VIEV» 28, B. Cheremushkinskaya St., 117218, Moscow, Russia

¹E-mail: safiullin_r.t@mail.ru

Abstract. Studies conducted in different regions of the country have shown that piglets up to 30 days of age are infected with isospores from 10 to 60%, with an invasion rate of 2 to 50 specimens in the field of view of the microscope. The average extensiveness of eimerious infestation in pigs across the country was 25.2%, with fluctuations in federal districts from 10.5 to 35.2%. The authors have tested and propose toltrazuril and diclazuril against the endogenous stages of young pig coccidia. Kenocox and Aymericide showed encouraging results against the exogenous stages of coccidia in the disinestation of pigsties. High efficiency is obtained from the complex use of drugs against exogenous and endogenous stages of coccidia.

1. Introduction

Analysis of the current state of animal husbandry shows that pork production in our country is carried out in specialized farms on an industrial basis, in farms with traditional technology (CJSC, LLC and others), in peasant farms and in private households. Pig breeding is one of the main branches of agriculture in the Russian Federation and many other countries. In terms of livestock and pork production, our country ranks fifth among the world's major producers. A certain decline that was observed in the 90s has been overcome, and today the share of pork in the structure of domestic meat production is 33.9%, and poultry meat is 47.8%.

Among the parasitic diseases of pigs, parasitic protozoa, intestinal nematodes and ectoparasites, which are quite widespread [1-3,4,5,6], occupy a special place. In recent years, both in our country and in many countries of the world where pigs are raised, parasitic protozoa - coccidiosis (isosporosis, eimeriosis) and balantidiosis, affecting pigs of different ages, have become especially relevant, but they have the greatest negative effect on the body in young animals. Piglets of 7-30 days of age are more often infected and more severely ill with isosporosis and with eimeriosis - up to 2 months of age and older. Pigs of older age groups suffer from mild coccidiosis [7, 8].

Despite the implementation of antiepizootic measures, complete prevention of parasitosis in pig farms is not achieved. This is evidenced by the work of domestic and foreign veterinary parasitologists [9,10-19].

The modern strategy of combating parasitic protozoa in industrial pig farms is reduced to a complex effect on the endo- and exogenous stages of protozoa using complex highly effective preparations.
Proceeding from the urgency of the problem, we set ourselves the task of studying the epizootic situation of coccidiosis and the effectiveness of new agents against endogenous and exogenous stages of parasitic protozoa pigs in industrial farms.

2. Materials and methods
The distribution of intestinal parasitic protozoa - isosporosis, eimeriosis, balantidiosis was studied in pig farms in the country in 2015-2018. The main research methods were coproscopic - Mac Master, Darling and Fulleborn. In addition, autopsies were performed on killed and dead pigs, a deep scraping was taken from the mucous membrane of the gastrointestinal tract and examined for the presence of parasitic protozoa. Coproscopic studies for protozooses were carried out in accordance with GOST 25383-82. The number of coccidial oocysts was counted using a Zeiss Primo Star microscope, eyepiece 10, objective 10 (40). The intensity of invasion was determined quantitatively in 1g of feces using a Mac Master chamber. When determining the species of coccidia, the washed culture of oocysts was placed in a Petri dish filled with a thin layer of 2.5% potassium dichromate solution, which was then kept in a thermostat at 26° C. The sporulation process was assessed by daily examination of the culture under a microscope.

The study of the effectiveness of prescribing drugs toltrazuril and diclazuril in a 5% concentration as a prophylactic course for isosporosis of piglets was carried out in a pig farm in the Moscow region by agreement with the farm veterinary service.

At the preliminary stage of the work, in order to establish the invasion rate (EI and IS), pregnant sows were subjected to coproscopic examinations according to the Mac Master method two weeks before farrowing. During the study, attention was paid to the parasitic protozoa: Isospora suis, Eimeria spp., Balantidium coli; from nematodes – Ascaris suum, Oesophagostomum dentatum, Trichocephalus suis. To establish the initial contamination of environmental objects with invasive elements, scrapings from the floor of machines, passages were taken and examined by the Darling method; walls of pens and feeders. Residual contamination of environmental objects was established after disinfection with a 4% sodium hydroxide solution. The preparation of pigsties-brood stock was carried out according to the technology adopted in the farm under the guidance of the veterinary service of the farm. Sows were transferred to farrowing within before 5 days.

There was one brood shed under supervision, divided into 4 sectors with 40 sows each. Weaning of queens from piglets in this farm was carried out at 23 days of age. After farrowing for 3-5 days of life, piglets of 1-3 sectors were prescribed a prophylactic course of drugs. Piglets of the first sector were prescribed toltrazuril 5% in a dose of 30 mg / kg DV per oral once. Piglets of the second sector were prescribed diclazuril 5% at a dose of 50 mg / kg DV per oral once. Juveniles of the third sector were given metronidazole at a dose of 15 mg / kg body weight orally once (base drug) for two consecutive days. Piglets of the fourth sector served as a control; they were given saline in a dose of 1 ml orally once.

During the entire test period, piglets of all sectors were kept in similar conditions of keeping and feeding. The veterinary service of the farm conducted daily clinical examinations.

Therapeutic and prophylactic efficacy of prescribing toltrazuril, diclazuril and metronidazole in isosporosis and eimeriosis of piglets was assessed based on the results of coproscopic examination of samples from piglets using the Mak Master method before prescribing drugs and at different times after giving. During the experiment, in the experimental and control sectors, in addition to coproscopic studies, autopsies were performed on dead and forcibly killed piglets, paying attention to the presence of characteristic signs on the part of the intestinal mucosa and the coccidial oocysts themselves when examined by the “native smear” method.

Together with the veterinary service of the farm, we took into account the safety of piglets of different groups during the observation period, the weight of one head at weaning and at 60 days of age, and the average daily weight gain.

The test of the effectiveness of complex disinfestation agents against exogenous stages of coccidia of young pigs “Kenokoks” and “Eymeriotsid” was carried out in the conditions of a pig complex in the
Moscow region by agreement with the veterinary service of the farm. The active ingredients of the drug “Kenokoks”: N-(3-aminopropyl)-N-dodecylpropane-1,3-diamine; alkyl(dimethyl)benzylammonium chloride. The complex preparation “Eymericide” has the following composition: active ingredients - thiazone, glutaraldehyde, lactic acid; auxiliary components - non-ionic surfactants and water.

The initial contamination of environmental objects with invasive elements was established by taking and examining by the Darling method scrapings from the floor of the pens, walkways, walls of the pens and feeders. Residual contamination of environmental objects was established 24 hours after disinfection.

For testing and constant observation, one brood shed was taken, divided into 4 sectors with 40 sows in each. During the preparation of the pigsty for disinfection of the 1st sector, a complex preparation “Kenokoks” 4% was used at a dose of 0.5 l per m2 with an exposure of two hours. For disinfection of the 2nd sector, another complex preparation “Aymeriotsid” 5% was used at a dose of 0.5 l per m2 with an exposure of two hours. For disinfection of sectors 3 and 4 (baseline), the recommended dose of 4% hot sodium hydroxide solution (80° C) was used.

After the preparation of the pigsty, the pregnant sows were transferred to farrowing and then they observed the growth of the young and assessed their infestation with coccidia according to the results of coproscopic studies in 10; 15; 22; 30; 45 and 60 days of age.

Testing the effectiveness of the combined use of drugs against the exo- and endogenous stages of coccidia was carried out using a similar method.

3. Results and discussion

Studies carried out in different regions of the country have shown that piglets under 30 days of age are infected with isospores from 10 to 60%, with an invasion rate of 2 to 50 specimens in the field of view of the microscope. The average extensiveness of eimerious infestation in pigs across the country was 25.2%, with fluctuations in federal districts from 10.5 to 35.2%.

The effectiveness of drugs for the endogenous stages of coccidia. Before setting sows for farrowing in the experimental pigsty, the floor, pens and all equipment were disinfected using the recommended dose of sodium hydroxide. 24 hours after treatment, the residual contamination of objects in the external environment of the pigsty with invasive elements was determined. When examining 20 samples from different parts of the floor after disinfection, coccidial oocysts were isolated in 2 (10%), balantidial cysts in 2 (10%) samples. In samples from the floor of the passages, coccidial oocysts and balantidial cysts were found in one sample (5%). All examined samples from the walls of the pens and feeders were free of invasive elements.

Our studies have shown that the system of preparation of queen sheds adopted in the farm for settlement and disinfection using the recommended dose of sodium hydroxide does not provide complete sanitation from invasive elements of intestinal parasitic protozoa, there is a residual contamination of environmental objects. In this situation, it is necessary to prescribe drugs as a therapeutic and prophylactic course for the endogenous stages of coccidia.

Studies have shown that piglets of the first and second groups, treated at 3 days of age with the marked doses of toltrazuril and diclazuril, were free of coccidial oocysts up to 28 days of age. Later, their infestation with isospores was noted by 5-10% and 5-15%, respectively. When studying at 49 and 56 days of age, no isospores were found. Infection with eimeria in these animals was noted at the age of 42; 49 and 56 days by 5-10 and 5-15%, respectively. Piglets of the third group, which received metronidazole, were infected with isospores from 28 days to 49 days of age, and eimeria from 35 to 56 days of age by 5-20%.

Animals of the control group were infected with isospores from 14 to 49 days of age by 5-30%, then their spontaneous release occurred. Infestation with eimeria was noted from 35 to 56 days of age by 10-40% with a high intensity of invasion.

The results obtained showed the high efficiency of the tested preparations of toltrazuril and diclazuril for coccidiosis of piglets on the 28th day of birth, then their invasion was noted.
The effectiveness of drugs for exogenous stages of coccidia. The results of the studies showed that the pigs obtained and raised in the first and second experimental compartments, where disinfection was carried out with Kenocox and Aymericide, were free of coccidial oocysts up to 22 and 15 days of age. Then their infestation with coccidia was noted by 5-20%. While piglets in the control group were infested with coccidia at all periods of the study, the EI ranged from 10 to 50%, with a high intensity of infestation.

Complex remedies Kenokoks and Aymericide, used to combat the exogenous stage of coccidia in the pigsty, provided bio-protection from oocysts for 2-3 weeks, then gradual infection of young animals was noted. Nevertheless, their invasiveness was 2.5 times lower than in control animals and at a low intensity of invasion.

4. The effectiveness of the combined use of drugs against exo- and endogenous stages of coccidia

After studying the effectiveness of individual use of drugs for exogenous and endogenous stages of coccidia of pigs, we set ourselves the task of testing the effectiveness of the combined use of drugs against exogenous and endogenous stages of coccidia in production conditions.

The work was carried out in a pig-breeding complex in the Moscow region in a brood-shed divided into 4 sectors with 40 sows in each. For disinfection during the preparation of the pigsty in sectors 1 and 2, a complex preparation Kenokoks 4% was used in the previously noted dose and exposure. For disinfection of sectors 3 and 4, the recommended dose of 4% hot sodium hydroxide solution (basic version) was used.

Residual contamination of objects in the external environment of the pigsty with invasive elements was established 24 hours after disinfection. When examining 20 samples from different areas of the floor of sectors 1 and 2 after disinfection by Kenocox, coccidial oocysts were found in 2 (10%), balantidial cysts in 2 (10%), in samples from the floor of the passageways, coccidia oocysts and balantidia cysts were found in one sample (5%). In the samples from the walls of the pens and feeders during the examination, invasive elements were not isolated.

In 20 samples from the floor of sectors 3 and 4, during examination after disinfection with caustic soda, coccidial oocysts were isolated in 2 (10%) and balantidial cysts in 3 (15%). In samples from the floor of the passages, coccidial oocysts were isolated in one (5%), balantidial cysts in 2 (10%). All examined samples from the walls of the pens and feeders were free of invasive elements.

The studies carried out have shown the presence of residual contamination with invasive elements in the brood stock shed where farrowing will take place and piglets will be raised.

Taking into account the results of studies on the residual contamination of the queen shed with invasive elements, the piglets of sectors 1 and 2 on the 3rd day of life were prescribed toltrazuril 5% in a dose of 30 mg / kg of body weight per day by mouth once. Piglets of sectors 3 and 4 were given saline in a volume of 1 ml orally once.

The effectiveness of the appointment of toltrazuril in coccidiosis and balantidiosis of piglets was assessed according to the results of coproscopic studies of samples from pigs at different times after administration.

When examining samples from piglets 1 and 2 sectors on 10; 15; 22; 30 and 45 days of life, which were given the marked dose of toltrazuril, no coccidial oocysts were found. When examining on the 60th day of life, coccidial oocysts were isolated in 2 samples, which is 10%. During the entire observation period, no balantidial cysts were found in piglets from sectors 1 and 2 when examining samples.

In piglets of the control group (sectors 3 and 4), coccidial oocysts from 15 to 60% were established at all periods of the study at a high intensity of invasion. Balantidial cysts in piglets of this group are isolated at 30; 45 and 60 days of age, extensibility ranged from 10 to 30%.

The results of the studies showed that piglets in sectors 1 and 2, treated at 3 days of age for the endogenous stages of coccidia with a marked dose of toltrazuril, where disinfection of sectors of the pigsty for exogenous stages of coccidia was carried out with the complex preparation Kenocox, were
free of coccidia and balantidia up to 45 days of age. Whereas piglets in the control group were infested with coccidia during all periods of the study (10-60 days), and balantidia from 30 to 60 days.

The complex use of drugs against exogenous and endogenous stages of coccidia significantly improved the level of biosecurity of the brood pigsties, which had a certain effect on production and economic indicators. Thus, the number of piglets born in sectors 1 and 2 was 784, and in sectors 3 and 4 - 768 heads.

In the first experimental group, the number of piglets weaned at 23 days of age from sows was 702, and in the second control group, 647 heads. The safety of piglets before weaning in the experimental group was 89.6%, in the control group - 84.2%.

In this farm, according to the production technology adopted by them, after weaning from the queens, the piglets remain up to 60 days of age on the same pens of the marked pigsty where they were raised. Piglets are transferred for growing at 60 days of age and their number in the experimental group was 686, and in the control group - 615. Over a two-month period of rearing, the safety of piglets in the experimental group was 87.5%, in the control group - 80.1%.

Before transferring to growing up, all piglets were weighed, which showed that the average live weight of the experimental pigs was 27.3 kg, while the control was 23.5 kg. For two months of observation of the piglets, the average daily weight gain of young animals was determined, which in the experimental group was 0.455 kg, in the control group - 0.392 kg (p <0.05). For a more accurate determination of the increase in live weight during the experiment, 30 piglets from each group were individually weighed. The cost of feed per unit of weight gain in the experimental group was 3.95 kg, in the control - 4.43 kg, the cost of the total weight gain was 107.8 and 104.1 kg.

The analysis of the data obtained showed that in the experimental group the total number of piglets retired in 60 days was 98, in the control group 153 heads. It should be noted that among the reasons for the death of piglets, their crushing by the uterus, malnutrition and diseases of the gastrointestinal tract. Among the reasons why piglets were subjected to forced slaughter, their weakness, growth and developmental lag.

The results obtained in the production experiment showed that the safety of piglets of the experimental group, which were prescribed toltrazuril against the endogenous stages of coccidia and grown in the sectors of the pigsty treated with Kenokoks - the drug against the exogenous stages of coccidia, was 7.1% higher than in the control group. The productivity of piglets in the experimental group for a two-month observation period in the form of an increase in live weight in the experimental group of pigs was 13.9% higher than in the control. Feed costs per unit of live weight gain in the experimental group of piglets were 12.1% less than in the control. The data on productivity are consistent with the results of coproscopic studies, which indicate that piglets from the experimental group, raised in the sections of the pigsty treated by Kenokoks and receiving the drug toltrazuril, were free from coccidia and balantidia up to 45 days of age, grew and developed better than the control ones due to prevention of parasitosis and prevention of a negative effect on the productivity of young pigs of intestinal parasitic protozoa.

Accounting for the costs of this work showed that the treatment of one pig with a 5% suspension of toltrazuril (baikoks) cost 4.6 rubles, disinfection of experimental compartments 1 and 2 with a total area of 1800 m² - 37,080 rubles, disinfection of control compartments 3 and 4 with a total similar area - 2520 rubles. For the processing of the experimental sections of the pigsty, 36 liters of Kenokoks concentrate were used.

The following initial information was used in the calculations: the price of 1 litre of Kenokoks concentrate is 1,029 rubles. The price of 1 kg of granulated sodium hydroxide is 28 rubles. the price of 1 package (250 ml) of 5% toltrazuril suspension is 1904 rubles. the selling price of 1 kg of live weight of young pigs in this farm at the time of work is 75 rubles. The price of 1 kg of compound feed for piglets 0-2 months of age is 4.5 rubles.

The calculation of the economic efficiency of the complex use of drugs against exogenous and endogenous stages of pig coccidia was carried out in comparison with the control group.

The following formula was used in the work:

\[\text{Economic Efficiency} = \frac{\text{Net Income}}{\text{Cost of Drugs}}\]
Eea = \[ ((C_e - C_e) + (G_P_e - G_P_c) + (C_B_c - C_B_e)) \times \ln \]

where:
Eea - economic efficiency of antiparasitic measures using new drugs against coccidia and balantidia, rubles,
Ce and Cc - current production costs per animal in the experimental (new) and control (basic) versions, rubles,
GPe and GPC - the cost of the gross production of pig breeding, obtained during the experiment, respectively, in the experimental and control versions, rubles,
CBc and CBe - the cost of feed costs for the resulting pig products in the experimental and control version, rubles,
ln - a livestock of pigs treated with a new drug.

Taking into account all the components, the economic effect from the comprehensive implementation of antiparasitic measures was:

Eea = \[ ((4.1 - 58.6) + (2048 - 1762) + (485 - 468)) \times 686 = 170\,471 \text{ rubles} \]

The economic effect of the complex implementation of measures against coccidia of pigs by using Kenokoks for disinfection of pigsties and toltrazuril by a prophylactic course to piglets for 3-5 days of life by mouth once in comparison with control animals per head was 248.5 rubles.

5. Conclusion
The results of the studies have shown that coccidiosis of young pigs in industrial farms is widespread and causes significant economic damage. The results of the production test showed that the combined use of drugs against exogenous (Kenokoks) and endogenous (toltrazuril) stages of coccidia provide high prophylactic and economic efficiency of their use in piglet coccidiosis.

References
[1] Akbaev M Sh, Vasilievich F I, Vodianov A A et al. 2008 Parasitology and Invasive Diseases of Animals (Moscow: Koloc) p 743
[2] Arnastauskiene T 1985 Coccidia and Coccidiosis of Domestic and Wild Animals in Lithuania (Vilnius: Moxlas) p 175
[3] Vershinin I I 1996 Animal Coccidiosis and Their Differential Diagnosis (Yekaterinburg: B.i.) p 264
[4] Kolabsky N A and Pashkin P I 1974 Coccidiosis of Farm Animals (Leningrad: Koloc) p 159
[5] Krylov M V 1996 Keys to Parasitic Protozoa (St. Petersburg: Zoological Institute RAS) p 693
[6] Orlov N P 1956 Coccidiosis of Farm Animals (Moscow: Selkhozgiz) p 166
[7] Kheisin E M 1967 Life Cycle of Coccidia of Domestic Animals (Leningrad: Nauka) p 192
[8] Khudyakov A A and Safiullin R T 2014 Guidelines for the Control of Pig Coccidiosis in Industrial Farms (Moscow) 22
[9] 2002 Sat. standard. legal documents on veterinary medicine: Veterinary legislation (Moscow: Roszooventsnabprom) p 635
[10] 1994 Guidelines for the Fight Against Eimeriosis and Isosporosis in Animals (Moscow: RAAS) p 30
[11] Rules for disinfection and disinfection of objects of state veterinary supervision (approved by the Ministry of Agriculture of the Russian Federation on July 15, 2002, No. 13-5-2 / 0525)
[12] Safiullin R T 2003 Therapeutic and prophylactic and economic efficiency of Sacox with eimeriosis of pigs Proceedings of VIGIS 39 236-48
[13] Safiullin R T, Sazanov A M and Khromov K A 2006 Guidelines for Determining the Economic Efficiency of Antiparasitic Measures (Moscow) 42
[14] Safiullin R T and Khudyakov A A 2016 Economic efficiency of measures for coccidiosis of pigs Proc. of the Sci. Conf. on Theory and Practice of Combating Parasitic Diseases 17 413-7
[15] Timofeev B A 1986 Prevention of Protozoal Diseases of Farm Animals (Moscow:
[16] Cherepanov A A 1999 *Guidelines for Testing Disinvasion Agents in Veterinary Medicine* (Moscow) 16

[17] Balicka-Ramisz A and Pilarczyk B 2014 Occurrence of coccidia infection in pigeons in amateur husbandry Diagnosis and prevention *Annals of parasitology* **60**(2) 93-7

[18] Joachim A, Altreuther G and Bangoura B 2018 Guideline for evaluating the efficacy of anticoccidials in mammals (pigs, dogs, cattle, sheep) *Veterinary parasitology* **253** 102-19

[19] Streyl K, Carlstron J and Dantos E 2015 Field evaluation of the effectiveness of an oral toltrazuril and iron combination (Baycox® Iron) in maintaining weaning weight by preventing coccidiosis and anaemia in neonatal piglets *Parasitology research* **114**(1) 193-200