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Research article

ENDOPARASITES IN SOWS AND SELECTED REPRODUCTION PARAMETERS

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The aim of the study was to analyze infection of sows with endoparasites depending on their physiological phase and length of exploitation, as well as to determine the effects of infection on selected parameters of reproductive performance. 300 fecal samples collected from the same 75 sows in 4 phases of the production cycle (dry sows, low pregnancy, high pregnancy, lactation) were tested in the experiment. Species and gender diversity, prevalence, OPG and EPG were determined in the study. These parameters were compared in terms of the physiological phase and the length of exploitation. Selected parameters of reproductive performance of sows were also examined, which were compared taking into account the length of exploitation and sows infection with individual parasites.

The study showed that the entire population was infected with two parasites at all physiological phases: *Eimeria* spp. (17% prevalence, 2275 OPG) and *Ascaris suum* (5% prevalence, EPG 79). The presence of parasites from *Eimeria* genus (prevalence 40%, OPG 2976) in sows exploited for 1 year had a negative effect on some parameters of their reproduction performance. Infected sows, compared to noninfected ones, were characterized by a lower number of live piglets (by 0.21 heads) ($p \leq 0.05$), a higher number of stillborn piglets (by 0.21 heads) ($p \leq 0.05$), as well as lower daily weight gains of piglets (by 15 g) ($p \leq 0.05$), which contributed to their lower weaning body weight (by 0.45 kg) ($p \leq 0.05$).

Key words: endoparasites, sows, physiological phase, exploitation

INTRODUCTION

A parasite is an organism that weakens the host through the use of food resources in its body [1]. The relationship itself is not intended to lead to the death of the host, but to the longest possible residence of the parasite in the host in order to prolong its life [2,3].

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Parasitic diseases are the cause of the decrease in production parameters in pigs in all technological groups [4-6]. The problem of parasitic diseases is important in relation to sows and fattening pigs, i.e., technological groups kept the longest in a herd [7]. The reaction of the host organism adaptation to the presence of the parasite can be compared to situations such as changes in the physiological phases of sows from the herd [8]. Parasite infection increases feed consumption, reduces growth rate especially in piglets born with low energy levels and inadequate condition of sows infected with internal parasites reduces milk yield [9-13]. Parasitic infections in sows can lead to reduced fertilization effectiveness, and it also negatively affects the embryos development in early pregnancy which causes that the largest losses due to infection are young animals that come into contact with the parasite for the first time [14-16]. The age at which the infection occurs is crucial for the productivity and use of the performance potential of the sows. The aim of the study was to determine the effect of the hybrid sows physiological phase and their period of exploitation on infection with endoparasites, as well as to examine the effects of herd infection on selected indices of sows reproductive performance.

MATERIAL AND METHODS

The experiment was carried out on a farm where the basic herd includes 1870 DanBred sows. The "deep" insemination method was used to fertilize the females. The planned level of herd renovation during the study was about 33%, while the ratio of primiparous to multiparous sows was constant (1: 5). Deworming of the sows was performed about 2 weeks before the end of pregnancy (Ivermektin 1% injection). During pregnancy, the sows stayed in group pens of 19 heads in each. The piglet rearing period lasted 26 days. Diarrhea was not observed during the experiment. The experiment was carried out from 2017 to 2018. The sows were divided according to the length of use into 3 groups (n = 25 in each group): group 1 - 1 year (1 or 2 farrowings), group 2 - 2 years (3 or 4 farrowings), group 3 - 3 years (5 or 6 farrowings). Parasitological analysis of the herd was based on quantitative and qualitative coproscopic methods. In the experiment, fecal samples were collected individually, each time from the same animals identified by the ear-tag number, and a spray for marking animals. Fecal samples were collected from the sows in four consecutive periods, i.e., dry sows (on day 3 after piglets weaning), low pregnancy (on day 45 of pregnancy), high pregnancy (on day 105 of pregnancy) and lactation (on day 14 of lactation). In each of the three groups 100 samples were taken (one from each sow, from all 4 physiological phases). In total, 300 fecal samples were collected in the whole experiment (75 samples in each physiological phase).

The biological material was collected from the ground immediately after defecation. A quantitative method using the McMaster chambers and the NaCl reagent according to the instructions of Gundłach and Sadzikowski was applied for eggs detection and isolation from feces [1]. The study by Zajac and Conboy (2006) was used to identify the eggs and oocysts [17]. To determine the infection level and parasites genus and species diversity, the following parasitological indices were used: prevalence (ratio of positive samples to the number of samples tested) and EPG and OPG mean (average number of eggs and oocysts in one gram of feces).The results of sows infection were compared in terms of physiological phase and the length of exploitation. The indices of noninfected and sick animals were also compared with the parameters of piglets rearing in the studied sows, i.e., the number of live and dead piglets (pcs), birth weight of piglets (kg), number of weaned piglets (pcs), piglets falls during the rearing (%), weaning weight of piglets (kg), daily weight gains of piglets (g).

The results were elaborated statistically with the use of STATISTICA ver. 10 program. The normality of the distribution was analyzed using W Shapiro-Wilk test. The significance of differences in the level of parasite invasion in individual groups of sows was verified on the basis of the independence test of two variables χ^2 with the Yates correction. To assess the significance of differences between EPGs, the non-parametric Mann-Whitney U test was used for two independent groups. The following significance levels were assumed: $p \leq 0.05$ and $p \leq 0.01$.

RESULTS

Eimeria spp. (prevalence 17%, 2275 OPG) and *Ascaris suum* (prevalence 5%, EPG 79) were diagnosed and identified in the examined population. The average prevalence of infection of all studied animals was 22%. The presence of *Eimeria* spp. and *Ascaris suum* was demonstrated in all physiological phases. The highest prevalence of *Ascaris suum* infection in the studied population was recorded in dry sows - 11% (Table 1).

Table 1. Infection of Eimeria spp. and Ascaris suum depending on the physiological stage of sows

Specification	Eimeria spp.			Ascaris suum		
	Prevalence	OPG		Prevalence	EPG	
	%	$\bar{x} \pm SD$	Me (x_{min} - x_{max})	%	$\bar{x} \pm SD$	Me(x_{min}-x_{max})
dry sows n=75	12 (n=9)	$2833^{A} \pm 2703$	2550 (50-15550)	11 (n= 8)	50 ± 100	100 (50-150)
low pregnancy n=75	23 (n=17)	$2750^{A} \pm 2110$	2600 (350-8900)	1 (n= 1)	100	100 (100-100)
high pregnancy n=75	19 (n=14)	$2055^{B} \pm 1980$	2800 (150-7500)	3 (n= 2)	100	100 (100-100)
lactation n=75	17 (n=12)	$1464^{C} \pm 1290$	1700 (100-4600)	5 (n=4)	65±35	100 (50-100)
mean n=75	17 (n= 12)	2275 ±11565	2700 (50-15550)	5 (n=4)	79±61	100 (50-150)

A, B, C - different letters in lines indicate statistically significant differences $p \leq 0.01$ between OPG in physiological phases.

In the case of population infection with *Eimeria* spp., the prevalence was the lowest in dry sows - 12%, and the intensity of infection was the highest - 2833 OPG, median 2550 (50-15550). Analysis of the intensity of infections of sows divided due to the length of exploitation (Table 2) showed that group 1 was characterized by the most intense infection with *Eimeria* spp. 40% of sows on average showed an infection with this parasite at 2976 OPG, median 2800 (50-15550).

Differences at the p≤0.05 level were found between the prevalence of group 1 infection in dry sows and during low pregnancy. The mean oocyst content in one gram of feces during the high pregnancy phase was 2455 OPG, median 2950 (150-7500), while during lactation it reached the lowest level of 1575 OPG, median 2050 (300-4600). Differences were demonstrated at the level of p≤0.01 between the dry sows and low pregnancy phase and the high pregnancy phase as well as the lactation phase. In sows in exploitation for 2 years, the prevalence of *Ascaris suum* infections in the dry sows and in the lactation phase was 8%, while in the pregnancy phase it was 4%. The presence of *Eimeria* spp. was recorded during pregnancy phases, with prevalence equal to 12%. In the low pregnancy phase, the intensity of infection was 433 OPG, median 350 (350-600), while in the high pregnancy phase it was the highest 1067 OPG, median 1,400 (150-1650). Sows used for 3 years showed prevalence of infection at 8% with OPG equal to 875, median 875 (750-1000) in the lactation phase. Differences were demonstrated at the level of p≤0.01 in OPG of *Eimeria* spp. between dry sows and low pregnancy phase, as well as the other phases of the production cycle. Analysis of the parameters of piglets reared from noninfected and infected sows showed that noninfected sows achieved better results in each of the compared parameters compared to infected sows (Table 3). However, the difference at the p≤0.05 level was recorded in the daily gains of piglets and their weaning body weight, which for noninfected sows were 257 g/day and 7.66 kg, and for the offspring of infected sows 246 g/day and 7.34 kg, respectively. Detailed analysis of piglet rearing parameters in terms of sow length of exploitation, as well as identification of animals as noninfected, infected with *Eimeria* spp. and infected with *Ascaris suum* showed statistically significant differences (p≤0.05) in sows used for one year_(Table 4). In group 1, noninfected females (n=15), compared to sows infected with *Eimeria* spp. (n=10), gave birth to 0.21 piglets more in the litter (p≤0.05) and 0.21 less stillborn piglets were noted (p≤0.05). Statistically significant differences (p≤0.05) were also demonstrated in the daily weight gain parameters of piglets (noninfected 245 g, infected with *Eimeria* spp. 230 g), as well as in weaning body weight (noninfected 7.53 kg, infected with *Eimeria* spp. 7.08 kg).

Table 2. Prevalence (%) and intensity of infection with *Eimeria* spp. and *Ascaris suum* depending on the length of exploitation and the stage of sows

Specification		*Eimeria* spp.			*Ascaris suum*		
		prevalence	OPG		prevalence	EPG	
		%	$\bar{x}$ ± SD	Me (x_{min} - x_{max})	%	$\bar{x}$ ± SD	Me (x_{min} -x_{max})
Group 1 n=25	dry sows	32 (n=8)	3969^{A} ± 10956	2550 (50-15550)	16 (n=4)	75 ± 25	75(50-100)
	low pregnancy	52 (n=13)	3342^{A} ± 5728	2700 (600-8900)	-	-	-
	high pregnancy	40 (n= 10)	2455^{B} ± 2663	2950 (150-7500)	-	-	-
	lactation	40 (n=10)	1575^{C} ± 2123	2050 (300-4600)	-	-	-
	mean	40 (n=10)	2976 ± 12043	2800 (50-15550)	4 (n=1)	75± 25	75(50-100)
Group 2 n=25	dry sows	4 (n=1)	200	200 (200-200)	8 (n=2)	150	150 (150-150)
	low pregnancy	4 (n=1)	800	800 (800-800)	4 (n=1)	100	100 (100-100)
	high pregnancy	4 (n=1)	1600	1600 (1600-1600)	4 (n=1)	100	100 (100-100)
	lactation	4 (n=1)	100	100 (100-100)	8 (n=2)	100	100 (100-100)
	mean	4 (n=1)	675 ± 670	500 (100-1600)	8 (n=2)	113 ± 25	100 (100-150)
Group 3 n=25	dry sows	-	-	-	8 (n=2)	50	50 (50-50)
	low pregnancy	12 (n=3)	433^{a} ± 94	350 (350-600)	-	-	-
	high pregnancy	12 (n=3)	1067^{b} ± 1251	1400 (150-1650)	4 (n=1)	100	100 (100-100)
	lactation	8 (n=2)	875^{b} ± 125	875 (750-1000)	8 (n=2)	75 ± 25	75 (50-100)
	mean	8 (n=2)	593 ± 277	750 (150-1000)	4 (n=1)	56 ± 43	50 (50-100)

a, b- different letters in lines mean statistically significant differences p≤0.05 between OPG in physiological stages of Group 3.
A, B, C- different letters in lines indicate statistically significant differences p≤0.01 between OPG in physiological stages of Group 1.

Table 3. Parameters of reproductive performance of noninfected sows and ones infected with *Eimeria* spp. and *Ascaris suum*.

Specification		Sows	
		noninfected (n = 58) $\bar{x}$ ± SD	infected (n= 17) $\bar{x}$ ± SD
number of born piglets [pcs]	alive	16.49^{a}± 3.07	16.34^{b} ± 2.87
	stillborn	0.73^{a} ± 1.03	0.93^{b} ± 1.12
number of weaner piglets [pcs]		12.65 ± 1.33	12.58 ± 1.41
losses of piglets [%]		23.3 %	23.0 %
body weight of piglets [kg]	birth	1.23 ±0.08	1.17 ± 0.12
	weaning	7.66^{a} ± 0.20	7.34^{b} ± 0.22
the daily weight gain of piglets [g]		257^{a} ± 11	246^{b} ± 20

a, b- different letters in lines indicate statistically significant differences p≤0.05 between healthy and infected sows.

Table 4. Parameters of reproductive performance of noninfected sows, sows infected with *Eimeria* spp. and infected *Ascaris suum* depending on the length of use

Specification		Number of born piglets [pcs]		Number of weaner piglets [pcs]	Loses of piglets [%]	Body weight of piglets [kg]		The daily weight gain of piglets [g]
		alive	stillborn			birth	weaning	
Group 1 n=25	noninfected n=15	15.32ᵃ± 2.42	1.02ᵃ± 0.73	12.30 ± 1.33	19.3	1.16 ±0.17	7.53ᵃ ± 0,20	245ᵃ ± 10
	Eimeria spp. infected n=10	15.11ᵇ± 4.74	1.23ᵇ± 1.22	12.28 ± 1.41	18.7	1.11 ± 0.19	7.08ᵇ ± 0.52	230ᵇ ± 20
Group 2 n=25	noninfected n=22	16.64 ± 1.53	0.53 ± 0.42	12.75 ± 1.19	23.3	1.23 ±0.14	7.73 ± 0.27	250 ± 14
	Eimeria spp. infected n=1	17	1	12	29.4	1.21	7.60	244
	Ascaris suum infected n=2	16	0.50±0.50	12.50±0.50	21.9	1.20±0.03	7.57±0.03	246±4
Group 3 n=25	noninfected n=21	16.85 ± 1.45	0.72 ± 1.02	12.65 ± 0.88	24.9	1.32 ± 0.24	7.85 ± 0.27	257 ± 42
	Eimeria spp. infected n=2	16.50	0.5 ±0.50	12.50 ± 0.50	24.2	1.27 ± 0.04	7.72 ± 0.20	250 ± 21
	Ascaris suum infected n=2	16	1±1	12	25.0	1.29±0.07	7.71±0.43	253±24

a, b- different letters in the rows denote statistically significant differences $p \leq 0.05$ in the performance parameters of Group 1 between healthy and infected sows of *Eimeria* spp.

DISCUSSION

The prevalence of infection of the studied population (22%) compared to the results of other authors [18] was at a moderate level. Parasites demonstrated in this study in pig production are common and have an economic significance [19-23]. Detailed analysis of species and genus diversity showed the greatest problem of infection with protozoa from *Eimeria* genus. The study with a division into the physiological state of the sows, showed the highest prevalence in dry sows (66.7%), followed by the sows in lactation (31.3%) [5]. The lowest prevalence was recorded in the sows during pregnancy (14.3%). A high level of infection in the low pregnancy phase can result from a number of causes. The first of these is the weakening of the organism after the effort of the previous lactation. According to the study, the organism in the low pregnancy phase is focused on the rebuilding of fatty and amino acid reserves [24]. Another reason for the high infection of pigs in the phase of low pregnancy may be the transfer of animals to group pens in which noninfected sows have direct contact with infected ones [25]. The preventive program should assume the maintenance of pigs in a way that prevents them from contact with infected animals and invasive forms of parasites, including eggs and oocysts [26-28]. The cause of high prevalence of infection during the high pregnancy phase may be the passage of parasites through the subsequent development cycles and their proliferation [2,14]. A detailed analysis of the infection depending on the physiological phases, as well as the length of exploitation showed that the sows of group 1 (1 or 2 farrowings) were the most infected with protozoa of the *Eimeria* genus (only anti-nematode agent was used). In the case of *Ascaris suum* infection, a variable level of infestation was noted. The infection of the youngest sow group and the females of groups 2 and 3 was differentiated by the number of deworming doses adopted. The system adopted on the farm assumes that sows are dewormed only once (2 weeks before delivery) during the whole reproductive cycle. This means that the youngest gilts had the drug administered only 1 or 2 times, while the oldest sows up to 6 times. Higher concentration of deworming agent, as well as previous contact of individuals with parasites allowed for immunity formation in older sows [29,30]. The results of breeding performance parameters clearly showed a negative effect of *Eimeria* spp. infection on the number of live and stillborn piglets, as well as the daily weight gain of piglets, which are directly related to weaning weight. The biggest differences were observed in the youngest sows. Young gilts need more energy to grow than older sows in order to achieve the appropriate body weight - which, by the young age of the first fertilization of gilts, was discontinued by pregnancy and fetal development [18,28,31,32]. Optimal feeding of pregnant sows is a key factor maximizing fertility and their longevity. It is important since the size of the litter and its weight increase to the fourth or fifth parity and the number of weaners per year increases until the sixth and seventh farrowing [33]. Gilt care is recommended to meet the requirements for proper development, growth and accumulation of reserves for the first lactation and to avoid a decrease in fertility in the next pregnancy [34].

In conclusion, high infection of sows exploitated for 1 year with *Eimeria* spp. caused a decrease in the number of live piglets, an increase in the number of stillborn piglets, as well as a reduction in the growth rate of piglets and weaning weight. Swine producers should focus on the youngest gilts and adapt an antiparasitic programme including coccidiostats for them, which will be based on a detailed diagnosis of infection.

Authors' contributions

Both authors are equally participated in the design of the study, wrote and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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ENDOPARAZITI KRMAČA I ODABRANI REPRODUKTIVNI PARAMETRI

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Cilj studije je bio da se obavi analiza invazije krmača endoparazitima u zavisnosti od fiziološke faze i dužine eksploatacije kao i da se odrede efekti invazije na odabrane parmetre reproduktivnih osobina. U okviru eksperimenta, ukupno je sakupljeno 300 uzoraka fecesa od 75 krmača i to u 4 faze reproduktivnog ciklusa (zasušene, rana suprasost, kasna suprasnost i laktacija). U toku studije, vršeno je određivanje vrste, rase i pola, prevalencija, OPG i EPG. Ovi su parametri upoređivani u odnosu na fiziološku fazu i dužinu trajanja eksploatacije životinja. Odabrani parametri reproduktivnih performansi krmača su takođe ispitivani, pri čemu je obavljeno njihovo poređenje uzimajući u obzir dužinu eksploatacije i invadiranost krmača pojedinim vrstama parazita.

Studija je pokazala da je cela populacija invadirana sa najmanje dva parazita tokom svih fizioloških faza i to: Eimeria spp. (17% prevalencije, 2275 OPG) i Ascaris suum (5% prevalencije, EPG 79). Prisustvo parazita roda Eimeria (prevalencija 40%, OPG 2976) kod krmača koje su u eksploataciji bile godinu dana, imalo je negativne efekte na pojedine parametre reproduktivnih osobina. Invadirane krače u poređenju sa neinvadiranim životinjama, imale su manji broj živih prasadi (za 0,21 jedinku) ($p \leq 0,05$), veći broj mrtvooprašenih potomaka (za 0,21 jedinku) ($p \leq 0,05$) kao i niže vrednosti dnevnog prirasta telesne mase prasadi (za 0,45 kg) ($p \leq 0,05$).