THE PHENOMENON OF SEXUAL DIMORPHISM IN THE CONTEXT OF REARING PIGS OF MODERN COMMERCIAL BREEDS UNDER CONDITIONS OF THE SOUTH OF UKRAINE

Ruslan Susol[1*], Katerina Garmatyuk, Oleksandr Tatsiy

[1]Odesa State Agrarian University, Odesa, Ukraine

Abstract

Our research aimed to study the effect of sexual dimorphism as a biological phenomenon on growth rates of young stock of different origin under conditions of breeding and commercial herds at the current stage of pig production development in the South of Ukraine. Sexual dimorphism (fm) in pigs of different genetic origin is defined as a ratio of the male to female body weight at a certain age, expressed as a percentage, with fm > 100% for a population with normal sexual dimorphism in body weight and fm < 100% for a population with reverse sexual body weight dimorphism. The following has been observed in young pigs of different origin during early ontogenic stages: boars tend to be heavier than gilts at birth, and such a pattern is maintained during the suckling period; however, this difference is levelled by 60 days of age; it results in trend changes in favour of gilts that outpace boars in terms of body weight at 90 and 120 days of age, which is indicative of their better adaptation to weaning. The difference between sexes at 150 days of age is levelled again, but by 180 days of age there is already a clear trend for greater body weight observed in boars as compared to gilts. Once representatives of the Large White and Pietrain breeds of both sexes reach a year or two years of age amid common pattern of normal sexual dimorphism in body weight, such outperforming of males over females is slightly more prominent for Large White animals as opposed to Pietrain pigs.

Key words: pigs – sexual dimorphism – body weight

INTRODUCTION

Economic traits in pigs of modern breeds include polyestricity, the absence of seasonality in reproduction, prolificacy (12 to 14 piglets per litter), farrowing index (2.3 to 2.5 litter per sow per year), early puberty (at 5.5 to 6 months of age), slaughter age (the age of reaching a slaughter weight of 100 kg is 165 days or less), low feed costs (3.0 kg of finished feed per 1 kg of live weight gain).

It is not feasible to achieve such high performances indices in pigs under conditions of commercial pig production not taking into account primary biological characteristics [8, 10].

Factoring in certain ins and outs in terms of biological features is a common practice of modern commercial pig farms. At the same time, scientists and practitioners in the livestock industry, especially in pig production, constantly look for new ways to reduce production costs through applying various innovative production technologies. Recently, increasing attention has been paid to the issues of sexual dimorphism for its potential to improve productivity of the breeding herd, as well as growing and fattening young stock [7].

MATERIAL AND METHOD

Our research was aimed at studying the effect of sexual dimorphism as a biological phenomenon on growth rates of young stock of different origin under conditions of breeding and commercial herds at the current stage of pig production development in the South of Ukraine. Our own on-farm data about live weights of pigs at different age, collected

[*]Corresponding author: r.susol@ukr.net
The manuscript was received: 18.04.2021
Accepted for publication: 21.04.2021

under conditions of Shabolat Ltd and Artsyz Meat Company Ltd in Odesa region, Ukraine, were used as research materials. The manifestation of sexual body weight dimorphism in purebred pigs of different breed-of-origin and crossbreds produced by combining the most popular swine breeds at the current stage of pig production development in the South of Ukraine was estimated at the age of 0, 30, 60, 90, 120, 150 and 180 days in purebred Large White pigs and hybrids from different breeds on the Shabolat Ltd pig farm (phase I of the research) and at the age of 0, 30, 60, 90, 120, 150, 180 days and 12, 24 months in purebred Large White and Pietrain pigs on the Artsyz Meat Company Ltd pig farm (phase II of the research) using the following formula:

$$fm = Xm / Xf \times 100\ \%,$$

where Xm is the average live weight of males (in kilogrammes); Xf is the average live weight of females (in kilogrammes). The value fm is a quantitative measure used as a qualitative characteristic of the total population of the animals in the genus *Sus*: fm > 100 % for a population with normal sexual dimorphism in body weight; fm < 100 % for a population with reverse sexual body weight dimorphism. A T-test (Student's criterion) was used to determine if there is a significant difference between the means [5]

RESULTS AND DISCUSSIONS

No statistically significant difference between sexes, as well as groups of pigs of different origin, has been found in the study of sexual dimorphism in body weight of boars and gilts of different origin at the stage I of the research (Tables 1 and 2). The lowest average live birth weight of the first new-born piglet, either a boar or a gilt, is observed in the purebred Large White animals in the control group I. The greatest piglet live birth weight is observed in litters from the IV experimental group of Large White sows mated with crossbred Cantor sires (½ Pietrain + ½ Duroc): 1.87 kg in new-born boars and 1.92 kg in new-born gilts. At 30 days of age, only boars in the I control group (with purebred Large White animals) and III experimental group ($F_1 \times F_1$) outperform their female age-mates in body weight by 5.2% ($p < 0.05$) and 2.2%, respectively. The differences in body weight between boars and gilts in the II, IV and V experimental groups is levelled. At the age of 60 days, gilts tend to surpass boars in live weight in the I control and II experimental groups while there is no difference between sexes in young stock of such an age in the III and V experimental groups. Only boars in the IV experimental group tend to outperform their female age-mates in live weight by 1.0%. There is a clear trend for the gilts outperforming boars in terms of body weight at the age of 90 days by 0.4 to 1.7% in all experimental groups. In particular, this trend of gilts having greater body weight as compared to boars, which coincides with the general tendency observed over the preceding period, is more apparent in the control group consisting of purebred Large White animals. Similar pattern for the revealed tendency of gilts having 1.0 to 1.9% greater body weight than boars at 120 days of age is observed in all experimental groups. However, by 150 days of age the situation has gone into reverse as there is practically no difference in live weight between sexes at this age. An analysis of the sexual body weight dimorphism manifestation at 180 days of age has yielded a trend for boars outpacing gilts in body weight by 0.3 to 3.2% in all experimental groups. We can establish a pattern of more pronounced difference in body weight between sexes in the control group of purebred Large White pigs and, inversely, no difference between the animals in the IV experimental group wherein crossbred sires (½ Pietrain + ½ Duroc) make up the parental line – such a difference is practically levelled, which indicates that both male and female progeny of the specified origin are better suited to the commercial pig fattening systems.

At the phase II of the research, the study of manifestation of sexual body weight dimorphism in young stock (from birth to 180 days of age) and mature pigs (at the age of 12 and 24 months) of ultra-lean Pietrain breed, as compared to those of Large White breed, it has been established that in the Large White young stock newborn boars tend to surpass newborn breed-mate gilts in terms of birth live weight by 6.8% (fm = 1.07). Similar pattern is observed for the Large White boars after

weaning (at 30 days of age) as they outperform their female age-mates in live weight by 6.7%. With regard to the sexual dimorphism parameters for the Pietrain breed, there is no difference in live weight at birth and at weaning between sexes (fm = 1.00-1.01), which, in our opinion, suggests that selective breeding for leanness over several generations resulted in levelling the difference in live weight between sexes as early as the initial ontogenic stages. The difference in live weight between sexes in Large White population is levelled at the age of 60 days (21.1 kg vs. 21.0 kg in boars and gilts, respectively).

Table 1 Age-related (30 to 180 days of age) sexual body weight dimorphism parameters in young stock of pigs of different origin, n=10

Parameters		I (LW x LW)	II (F_1 x LW)	III (F_1 x F_1)	IV (LW x Cantor)	V (LW x L)
At birth						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	1.48±0.03	1.74±0.08*	1.82±0.08**	1.88±0.03***	1.82±0.05***
	Cv,%	6.15	12.48	12.05	3.66	7.57
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	1.40±0.05	1.79±0.13	1.74±0.05	1.87±0.06	1.81±0.03
	Cv,%	9.96	19.92	7.56	8.75	3.99
At 30 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	7.51±0.12	8.86±0.13	9.22±0.16	9.48±0.13	9.34±0.15
	Cv,%	5.16	4.76	5.38	4.47	5.08
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	7.14±0.11	8.90±0.18	9.02±0.16	9.44±0.16	9.29±0.15
	Cv,%	4.99	6.51	5.72	5.36	5.24
At 60 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	20.19±0.43	22.40±0.52	23.50±0.60	24.30±0.42	24.15±0.53
	Cv,%	6.75	7.35	8.09	5.50	6.90
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	20.50±0.42	22.57±0.45	23.46±0.65	24.07±0.54	24.20±0.62
	Cv,%	6.50	6.29	8.73	7.05	8.04
At 90 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	34.80±0.53	36.30±0.47	36.70±0.62	38.45±0.59	37.40±0.56
	Cv,%	4.86	4.1	5.31	4.84	4.76
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	35.40±0.45	36.55±0.59	37.10±0.62	38.60±0.70	37.90±0.59
	Cv,%	4.04	5.09	5.31	5.75	4.88
At 120 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	55.05±1.07	57.70±0.80	58.05±0.83	60.20±0.88	59.50±0.78
	Cv,%	6.12	4.40	4.53	4.62	4.13
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	56.10±0.97	58.30±0.92	58.70±0.99	61.00±0.93	60.10±0.77
	Cv,%	5.47	4.99	5.33	4.82	4.03
At 150 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	78.10±1.33	81.00±1.14	80.60±1.20	82.40±1.19	81.45±1.07
	Cv,%	5.38	4.47	4.69	4.55	4.15
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	78.00±1.26	80.80±1.11	79.40±1.15	82.80±1.04	80.73±1.03
	Cv,%	5.09	4.36	4.57	3.97	4.05
At 180 days of age						
Live weight (♂), kg	$\bar{X} \pm s_{\bar{x}}$	105.60±1.19	106.30±1.69	106.50±1.67	109.30±1.90	108.1±1.43
	Cv,%	3.55	5.01	4.96	5.51	4.17
Live weight (♀), kg	$\bar{X} \pm s_{\bar{x}}$	102.30±1.53	104.90±1.43	104.40±1.80	109.00±1.51	106.8±1.59
	Cv,%	4.74	4.30	5.46	4.41	4.71

Notes: * p< 0.05; ** p < 0.01; *** p < 0.001.

We consider that it can be associated with the fact that females are better adapted to new feeding and housing conditions after weaning. The piglets were weaned at 28 days of age. The first 14 days after weaning are known to be the most critical period. For the Pietrain breed, we revealed that gilts tend to outperform boars in live weight at 60 days of age by 3.03% (fm = 0.97; 20.4 vs. 19.8 kg in gilts and boars, respectively).

Table 2 Age-related (0 to 180 days of age) sexual body weight dimorphism (fm) in young stock of pigs of different origin, n=10

Age in days	I (LW x LW)	II (F_1 x LW)	III (F_1 x F_1)	IV (LW x Cantor)	V (LW x L)
0	105.7	97.2	104.6	100.5	100.6
30	105.2	99.6	102.2	100.4	100.5
60	98.5	99.2	100.2	101.0	99.8
90	98.3	99.3	98.9	99.6	98.7
120	98.1	99.0	98.9	98.7	99.0
150	100.1	100.2	101.5	99.5	100.9
180	103.2	101.3	102.0	100.3	101.2

The case study for this ultra-lean breed can be reckoned as an additional evidence of better adaptation of female body during the critical period immediately after weaning.

Sexual dimorphism in live weight of Large White young stock during the subsequent growth stages (at 90, 120, 150 and 180 days of age) should be considered as normal sexual body weight dimorphism, though only a trend for the boars outpacing gilts by 2.0 to 3.0% can be clearly observed. During the subsequent growth stages of young stock (at 90, 120 and 150 days of age), the Pietrain population tends to show reverse sexual dimorphism in live weight as gilts surpass boars by 1.0 to 4.0%.

There is a significant difference in live weight between sexes of both Large White and Pietrain breeds once they reach a year age as the boars outperform gilts in live weight by 18% and 14% ($p < 0.001$), respectively; at the age of two years, this difference makes 43% and 40% ($p < 0.001$), respectively, which fully conforms to the normal sexual dimorphism pattern.

DISCUSSION

The phenomenon of sexual dimorphism in mammals implies that males tend to be larger in size and to have higher growth rates and longer period of growth as compared to females. Wild boar can be regarded as representative of this genus as the average body weight of males is noticeably greater than that of females. Such an advantage in body weight is inherited by commercial swine breeds from this wild progenitor [9].

According to [6], females are larger than males in most of living beings. Paradoxically, sexual body size dimorphism in most mammalian species is shifted towards males, which is commonly associated with the fact that sexual dimorphism in mammals is the result of sexual selection within male populations, that is, in order to preserve their genes, males should be larger in size which secures their advantage over other species and makes it possible to mate with greater number of females. As a consequence, genes of males that are larger in size are transmitted from one generation to the next. Therefore, in our opinion, it is not only sexual, but also natural selection that plays a leading role in sexual dimorphism.

According to another theory, sexual dimorphism in body size and weight may be explained by direct or indirect action of genes responsible for primary sexual characters [3].

Table 3 Age-related (0 to 24 months of age) sexual body weight dimorphism parameters in young stock of pigs of different origin

Parameters		I (FLW)		fm	II (FP)		fm
		♂	♀		♂	♀	
At birth, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	1.41±0.04	1.32±0.04	1.07	1.70±0.05	1.69±0.05	1.00
	Cv,%	9.72	8.60		8.77	10.23	
At 30 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	8.0±0.14	7.5±0.20	1.07	8.7±0.26	8.6±0.22	1.01
	Cv,%	5.58	8.31		9.43	8.13	
At 60 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	21.1±0.38	21.0±0.56	1.00	19.8±0.59	20.4±0.46	0.97
	Cv,%	5.76	8.38		9.49	7.14	
At 90 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	35.9±0.72	35.3±0.56	1.02	34.3±0.84	35.60±0.73	0.96
	Cv,%	6.36	5.0		7.78	6.51	
At 120 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	56.7±0.90	55.2±0.94	1.03	54.9±1.21	57.10±1.09	0.96
	Cv,%	4.99	5.39		6.95	6.04	
At 150 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	83.4±1.23	82.0±1.26	1.02	82.8±1.54	84.0±1.20	0.99
	Cv,%	4.67	4.84		5.88	4.52	
At 180 days of age, n = 10							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	116.7±1.70	114.9±1.73	1.02	115.4±3.24	113.1±2.54	1.02
	Cv,%	4.61	4.77		8.88	7.12	
At 12 months of age (♀ n = 10; ♂ n = 5)							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	246.8±5.27***	208.4±3.38	1.18	218.2±4.88***	192.2±3.39	1.14
	Cv,%	4.79	5.08		5.00	5.58	
At 24 months of age (♀ n = 10; ♂ n = 3)							
Live weight, kg	$\bar{X} \pm s_{\bar{x}}$	352.0±6.43***	246.2±4.0	1.43	310.0±5.86***	221.1±4.25	1.40
	Cv,%	3.16	5.14		3.27	6.08	

Notes: * $p < 0.001$.

The analysis has confirmed that the pattern of sexual size dimorphism in domestic swine does not conform to Rensch's rule. It is proposed that this is due to the fact that males and females have been subjected not solely to a sexual selection regimen, but also to environmental factors, interspecific competition with other domestic species, an increase of intersexual food competition, poor feeding resources and reproductive functional constraints. Considering all of the breeds studied, it is also likely that different counteracting selective pressures exist worldwide [4].

Three studies were conducted to determine the effect of sex on pre- and post-weaning performance of pigs. Those studies were carried out in response to observations that female pigs appeared to grow faster than male pigs after weaning. In addition, female pigs were found to grow faster than male pigs when supplied with supplemental milk before weaning. The aim of the study was to further characterise the ontogeny of sex differences in growth of nursing and growing pigs. However, such differences were not maintained over the entire experimental period in each shed. Such data corroborated hypotheses that gilts handle stresses at weaning and during other transition periods better than boars [2].

Sex-separate rearing of broilers that allows of keeping feed costs down and prolonging the period of male broiler production can serve as a good case study of successful factoring in sexual dimorphism in poultry industry. It was suggested that sex separation could result in increased company

profitability and have possible beneficial effects at theprocessing plant due to increased bird uniformity [1].

Therefore, in our opinion, all the aforementioned specific growth features of young stock of pigs of different sex can be associated with puberty, which usually begins earlier in females, and subsequent growth period that is shorter in females as compared to males.

CONCLUSION

1. The following has been observed in young pigs of different origin during early ontogenic stages: boars tend to be somewhat heavier than gilts at birth, and such a pattern is maintained during the suckling period; however, after weaning this difference is levelled by 60 days of age; during the subsequent ontogenic stages it results in trend changes in favour of gilts that outperform boars in terms of body weight at 90 and 120 days of age, which is indicative of their better adaptation to weaning. The difference between sexes at 150 days of age is levelled again, but by 180 days of age there is already a clear trend for greater body weight observed in boars as compared to gilts.

2. Studying specific features of growth of Large White and Pietrain pigs (phase II of the research) has revealed a more pronounced tendency for the manifestation of normal sexual dimorphism in live weight during the period of rearing Large White young stock till the age of 180 days whereas Pietrain young stock tends to exhibit reverse sexual body weight dimorphism at 60-150 days of age, which, in our opinion, is associated with selective breeding for better leanness of the Pietrain breed. Once representatives of the Large White and Pietrain breeds of both sexes reach a year or two years of age amid common pattern of normal sexual dimorphism in body weight, such outperforming of males over females is slightly more pronounced for Large White animals as opposed to Pietrain pigs.

3. We find it worthy to follow the example of poultry meat production and to examine the efficiency of sex-separate rearing of gilts, boars and barrows with simultaneous correction of energy and protein feeding. Such improved feeding programmes will be prioritised in our future research.

REFERENCES

[1]. Costa M.J. Da, Colson G., Frost T.J., Halley J., Pesti G.M. Straight-run vs. sex separate rearing for two broiler genetic lines Part 2:Economic analysis and processing advantages. Poultry Science. 2017. Vol 96, Issue 7: p 2127-2136

[2]. Frank Rowland Dunshea. Sexual Dimorphism in Growth of Sucking and Growing Pigs. Asian-Aust. J. Anim. Sci. 2001. Vol 14, Issue 11 : p 1610-1615.

[3]. Haqq C.M., Donahoe P.K. Regulation of sexual dimorphism in mammals. Physiol. Rev. 1998;78(1):33.

[4].https://www.researchgate.net/publication/259383581_Sexual_Size_Dimorphism_in_Swine_Denies_Rensch's_Rule

[5]. Kramarenko S. S. , Luhovyi S. I., Lykhach A. V. Analiz biometrychnykh danykh u rozvedenni ta selektsii tvaryn [Analysis of biometric data in animals breeding and selection: textbook]. Mykolaiv, 2019 [in Ukrainian].

[6]. Marcelo H. Cassini. A mixed model of the evolution of polygyny and sexual size dimorphism in mammals. Mammal Review. 2020 (50): p 112-120.

[7]. Pelykh V.H. Selektsiini Metody Pidvyshchennia Produktyvnosti Svynei [Breeding methods to increase pig productivity], Kherson, 2002 [in Ukrainian].

[8]. Susol R. L.. Naukovo-praktychni metody vykorystannia svynei porody pietren u systemi «henotyp × seredovyshche» [Scientific and practical methods for the use of pigs Pietrain breed in the genotype × environment system: monograph.]. Odesa, 2015 [in Ukrainian].

[9]. Vieites C.M., Basso C.P. Bartoloni N. Wild boar (Sus scrofa ferus): productivity index in an experimental outdoor farm. In. Vet. 2003;5 (1): p 91-95.

[10]. Voloshchuk V. M. Svynarstvo : monohrafiia [Swine breeding]. Kiev, 2014 [in Ukrainian].