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Effect of birth body weight of piglets on their rearing up to the age of 10 weeks

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Abstract: *The effect of birth body weight of piglets on their rearing up to the age of 10 weeks*. The aim of the paper was to evaluate the effect of the birth body weight of the piglets on their productivity and survivability up to the age of 10 weeks. The observations covered the piglets born by 11 sows F1 of Polish Large White × Polish Landrace, inseminated by the semen of the boras (Duroc × Pietrain). The piglets were weighed on 1st, 21st, 35th and 70th day of life and the feed intake (per litter) was controlled. Depending on their birth body weight, the piglets were classified into two groups: light (L) <1.5 kg (n = 52), heavy (H) ≥1.5 kg (n = 60). The mean general body weight of the piglets on 1st, 21st, 35th and 70th day was equal to 1.45, 5.09, 7.70 and 14.18 kg, respectively. In the groups, it was as follows: L – 1.17, 4.58, 6.91 and 13.00 kg; H – 1.70, 5.51, 8.29 and 15.12 kg, respectively (L–H, P ≤ 0.001). The deaths of the piglets in groups L and H amounted to 15.4 and 6.7%, respectively. In the situation of a free access of the progeny to mother's feed and solid feedstuff, the obtained results indicate that the worse productivity, as expressed by lower feed conversion (by 10.5–16%), slower growth rate (by 12–20%) and lowered survivability (by 8.7 percentage points) of the piglets from groups L vs. group H, were the effect of considerably lower body weight of the newborn piglets as compared to their mean body weight.

Key words: piglets, body weight, growth rate, survivability

INTRODUCTION

In spite of the improvement of management techniques and intensive studies concerning nutritional requirements of mammals during the recent half of the century, low body weight still becomes a serious problem in animal production and the knowledge on the effect of nutrition on mechanisms, regulating the growth of foetus, has become incomplete (Wu et al. 2006, Rekiel et al. 2014a).

The growth and development of foetuses is affected by genetic and environment (Redmer et al. 2004). Due to incidence of IUGR (intrauterine growth retardation), we state the occurrence of considerable losses of foetuses in farm animals, in the initial as well as in the middle and final period of gestation (Wu et al. 2006). The environmental factors, favourable for IUGR and low body weight include; nutrition of mother (low or high consumption of feed and lack of balance of nutrients). The effect is also affected by temperature of environment and stress, and bad management conditions (Redmer et al. 2004, Wu et al. 2004a).

Insufficient volume of uterus and inadequate (compared to the requirements) nutrition are the main reasons for retardation of foetus growth and low body weight (Redmer et al. 2004). The environment of uterus may affect the size of foetuses; it was revealed in

various pig breeds. The available data indicate that the prenatal growth of all higher mammals (placenta mammals) is dependent on the direct and indirect effect of mother's nutrition and uterus volume (Robinson et al. 1999, Allen et al. 2002, cited by Rekiel and Królewska 2014, Ferguson 2005).

As compared to the offspring with a high or normal birth body weight, the newborns with light body weight, i.e. lambs, piglets or foals often die, and they need more time as to adapt themselves to postnatal life. At the moment of birth, the heavier young animals are more vital and they adapt more quickly to extrauterine environment (Wu et al. 2004a, b). From among domestic animals, most frequently in the case of pigs, light body weight and intrauterine growth retardation (IUGR) occur naturally what is connected with the high fertility of the mentioned species. In the case of the piglets with light body weight and IUGR, we find structural and functional changes, including the changed structure of the whole body, muscles and types of muscle fibres, higher content of intra-muscular fat, less skeletal muscles, weakened growth of the whole body since the birth until slaughter, weaker feed conversion as compared to the piglets with high body weight at birth, worse quality of slaughter raw material and pork meat (Gondret et al. 2005, Karunaratne et al. 2005, Rehfeldt et al. 2008, Rekiel et al. 2013a, b, Rekiel et al. 2014a, b).

The aim of the work was to examine the effect of the body weight of the piglets at birth on their rate of growth, feed conversion and survivability until 70th day of life.

MATERIAL AND METHODS

The piglets for the studies derived from eleven sows F1 of Polish Large White × Polish Landrace, inseminated with the semen of crossbred boar Duroc × × Pietrain. The pregnant females (after 3 week of gestation) were kept in group pen and one week before the parturition, they were transferred to parturition pens; they stayed there until weaning of the piglets (5 weeks). The study covered 112 piglets from birth until 70th day of life.

The pregnant and suckling sows were individually fed the mixture of barley and wheat meal and protein concentrate (Table 1). The participation of cereal

TABLE 1. Energy content and feeding value of concentrate for sows

Specification	Concentrate
Metabolic energy (MJ)	11.8
Crude protein (%)	32
Crude fat (%)	2.60
Crude ash (%)	16.50
Phosphorus (%)	1.20
Lysine (%)	2.94
Crude fibre (%)	5.50
Vitamin A (i.u./kg)	71 500
Vitamin D_3 (i.u./kg)	14 300
Vitamin E (i.u./kg)	371
6-Phytase EC (FTU/kg)	4 290
Copper (mg/kg)	57.2

meals and concentrate was as follows: mixture LP – 82.5 and 17.5% and LK 80 and 20%, respectively. In low and high gestation, the rate of 2.4 kg/animal/day and 3.0 kg/animal/day was employed. During lactation period, the rate was dependent on the number of fed piglets (Standards of Pig Nutrition 1993). The piglets were additionally fed the mixture of prestarter type and after weaning – with starter mixture (Table 2).

TABLE 2. Energy content and feeding value of mixture for piglets

Specification	Prestarter	Starter
Metabolic energy (MJ)	13.6	13.4
Crude protein (%)	18.00	17.00
Crude fat (%)	5.10	3.00
Crude ash (%)	5.20	4.50
Phosphorus (%)	0.53	0.35
Lysine (%)	1.13	1.11
Crude fibre (%)	3.60	3.80
Vitamin A (i.u./kg)	12 000	12 000
Vitamin D_3 (i.u./kg)	2 000	2 000
Vitamin E (i.u./kg)	100	50
Phytase (FYT/kg)	603	750
Copper (mg/kg)	160	15

The newborn piglets were subject to basic zootechnical treatment; they were marked at birth; they received iron preparation (Ferrovet) on 3rd day of life; they received ear rings on 21st day. The body weight of the piglets, their deaths and feed intake by the litter were controlled on 1st, 21st, 35th and 70th day of life. After 35 days of rearing, the piglets were transferred to pens without the change of the structure of the group and they were reared up to the age of 10 weeks. The analysis of the rearing results was conducted after classification of the piglets into two groups, differing in body weight; light piglets (L) < 1.5 kg BW, n = 52 (mean BW in the group was 1.17 kg; the number of boar piglets 29 heads; gilts 23 heads); heavy piglets (H) > 1.50 kg BW, n = 60 (mean BW in group 1.70 kg; boar piglets 30 heads, gilts 30 heads) (L–H, $P \leq 0.001$).

The results have been statistically tested using SPSS Statistics 21 software. Normality or results has been checked using the Shapiro-Wilk test. The differences between the groups have been analysed using the t-Student test (for traits with normal distribution, i.e. body weight on 21st and 35th day of life) or the U Mann-Whitney test (for all other traits).

RESULTS AND DISCUSSION

The mean body weight of all examined piglets was average, typical of the species and it amounted to 1.45 kg at birth. The number of the piglets born in the litter was equal in average to 10 animals (8–14 piglets/litter), sex ratio – male : : female equals 1.1 : 1), deviating from the standard equal to 1 : 1 but it was confirmed at various animal species (Rekiel et al. 2010).

The piglets from groups L and H revealed the increase of their body weight during the successive weightings (Table 3). Body weight of the piglets at birth in group L vs. group H was lower; it amounted to 68.8% of BW in group C

TABLE 3. Body weight of light (L) and heavy (H) piglets during rearing period

Item	Group L < 1.5 kg	Group H ≥ 1.5 kg	P
Body weight at birth (kg)	1.17	1.70	0.001
Body weight on 21st day of life (kg)	4.58	5.51	0.001
Body weight on 35th day of life (kg)	6.93	8.30	0.001
Body weight on 70th day of life (kg)	13.00	15.11	0.001

and on 70th day of rearing it was equal to 86.7%. The resulting change may indicate the compensation of growth in the piglets of group L. In the opinion of the researchers, it is possible (Rehfeldt et al. 2011, 2012a, 2012b, cited by Rekiel et al. 2014a); in the specified case, it has a limited extent. It seems, however, that in the own studies the discussed difference could result in a greater degree from the fact of the increased deaths of the piglets to be weaned in group L as compared to group H. The losses concerned very light piglets: in group L, 8 piglets died and their mean birth weight was equal to 0.92 kg; in group H, 4 piglets died and their mean birth body weight amounted to 1.70 kg. The differences between the groups of the piglets L and H were also characterized by body weight of the heaviest individuals on 70th day of life: in groups L and H, it was 16.85 and 20.15 kg, respectively (difference of 3.30 kg in favour of group H vs. group L, i.e. 19.58%). The progress of body weight of the piglets was lower until the moment of weaning in group L vs. group H. The changes in the groups were as follows: 1–21 day – 3.41 and 3.81 kg, respectively; 21–35 day – 2.33 and 2.78 kg, 35–70 day – 6.09 and 6.03 kg, respectively; the difference in the further successive periods in group H vs. group L was: +11.73, +19.31 and –0.99%. The recent result confirms the mentioned earlier compensation of growth. Lack of capacity of increasing the protein synthesis in tissues explains the incomplete compensation of growth during the postnatal period. The longer is the period of intrauterine limitation of nutrients, the lower are the capabilities of the IUGR pigs to restore their correct condition (Rehfeldt et al. 2011, 2012a, 2012b, cited by Rekiel et al. 2014a).

In the group of the piglets L since birth until 21st day of rearing, 6 piglets died what constituted 75% of losses; the remaining 25% occurred during the period after weaning. In the group of the piglets H, also 75% of deaths had place up to 21st day, but there were only 3 animals; the successive 25% concerned the period before weaning. The level of losses until 10th week of life was higher in group L vs. group H and it amounted to 15.4 and 6.7%, respectively Herpin et al. (2002) and Wolter et al. (2002), cited by Rekiel et al. (2013b), Gondret et al. (2005), Rehfeldt et al. (2008) state that a low birth body weight is relating to the lowered survivability of the piglets. In the groups of the piglets L, the deaths after weaning could be caused by weaning

stress and weaker development of internal organs, *inter alia*, of gastrointestinal system (Wang et al. 2005) in 2 animals, the birth body weight of which was low and amounted to 0.99 and 1.09 kg, respectively. During the whole rearing period, the mortality of boar piglets was higher than that of gilts; in total, 7 males and 5 females died (deaths in group L – 4/4, in group H – 3/1). In the studies of Bocian et al. (2011), the mortality of the piglets was the highest up to 21st day and concerned mainly the individuals, the birth body weight of which was lower than 1.2 kg. The losses in the discussed group were equal to 24.49%; on the other hand, among the piglets with body weight of 1.2–1.6 kg, it amounted to 6.78%. Bocian et al. (2011) recorded the lowest mortality among the piglets weighing at birth beyond 1.6 kg (only 4%). Dysfunctions of intestines and respiratory system are the main factors, predisposing the newborns to higher mortality rate before weaning (Wu et al. 2004b).

The higher level of losses and slower growth rate of the piglets lighter at birth and the disorders in postnatal development of muscle fibres and skeletal muscles are explained by the results of the studies and monographic descriptions, published in scientific foreign and national periodicals (Wu et al. 2004b, Rekiel et al. 2013a, 2013b, Rekiel et al. 2014c). Small intestine plays an important role in final digestion and absorption of nutrients and postnatal growth of animals (Wang et al. 2005). Naturally occurring or experimentally induced IUGR is related with the incorrect morphology of alimentary tract and stomach-intestinal disturbances what contributes to decrease of utilization of nutrients coming from feed (Wu et al. 2004a). The mean intake and conversion of feed has been given in Table 4. The conversion of feed, as expressed by the degree of changes

TABLE 4. Feed intake and conversion in the successive periods of rearing the piglets

Period of rearing (days)	Mean feed intake by the litter (kg)	Mean feed intake by one piglet (kg)	Piglets light at birth – 1.17 kg (L)	Piglets heavy at birth – 1.70 kg (H)	Ratio of changes in feed conversion by the piglets, H vs. L (%)
			Feed conversion (kg/kg of body weight gain of one piglet)		
Since 1st up to 21st day	2.56	0.25	0.074	0.066	–10.55
Since 21st up to 35th day	6.75	0.72	0.309	0.259	–16.16
Since 35th up to 70th day	6.30	0.69	0.114	0.102	–10.81
Since 1st up to 35th day	9.31	1.00	0.173	0.151	–12.87
Since 1st up to 70th day	15.62	0.25	0.145	0.128	–11.72

in group H vs. group L occurred to be better by ca. 10.5–16%. It had also the influence on growth rate which was revealed to be higher in the case of the piglets heavier at birth as compared to the lighter animals. The ratio of the changes depending on the rearing period was equal to ca. 12–20% (Table 5). The highest body weight gains were reached by piglets H vs. L since 21st up to 35th day of life; the difference amounted to 33 g.

TABLE 5. Growth rate of the piglets

Period of rearing (days)	Piglets light (L) at birth with mean body weight of 1.17 kg		Piglets heavy (H) at birth with mean body weight of 1.70 kg		Ratio of changes in daily body weight gain for piglets H vs. L (%)
	Mean body weight gain of piglet (kg)	Mean daily gain (g)	Mean body weight gain of piglet (kg)	Mean daily gain (g)	
Since 1st up to 21st day	3.41	162	3.81	181	11.73
Since 21st up to 35th day	2.33	166	2.78	199	19.88
Since 35th up to 70th day	6.09	174	6.83	195	12.07
Since 1st up to 35th day	5.74	164	6.59	188	14.63
Since 1st up to 70th day	11.83	169	13.42	192	13.61

Bocian et al. (2011) confirmed a significant effect of body weight at birth on the growth rate of the piglets during rearing period. The piglets with the lower body weight had slower weight gains during the discussed period and they also reached weaker fattening results. Gondret et al. (2005), Rehfeldt et al. (2008) and Herpin et al. (2002) and Wolter et al. (2002), cited by Rekiel et al. (2013b) state that in the case of low body weight of the newborn animals, the indicators of growth in the postnatal period until reaching the slaughter weight, are lowered.

The conducted own studies as well as the selected examples of the studies carried out in various scientific centres by different research teams (Wallace et al. 2005, Wu et al. 2006, Rehfeldt et al. 2008, Bocian et al. 2011, Van Vliet et al. 2013) indicate the meaningful effect of the body weight of the newborn animals at birth on production results, including their rate of growth and survivability. The low birth body weight is connected with IUGR syndrome. IUGR occurs in economically important utility animals, including pigs (Rekiel and Królewska 2014). In spite of the improvement of management techniques and intensive studies in respect of the nutritional requirements of mammals, IUGR still re-

mains the important problem in breeding due to the incomplete knowledge on the effect of nutrition on mechanisms, regulating the foetuses' growth (Wu et al. 2004a, Murphy et al. 2006). Finding the solution for the discussed problem will have a meaningful influence on the improvement of the rearing results and by this, profitability of production.

CONCLUSIONS

In the compared groups and periods, the average rate of growth of the examined piglets was found; it did not exceed 200 g. It was revealed that the piglets with the lower body weight at birth (group L) as compared to heavier piglets (group H) were characterized by slower growth rate ($P \leq 0.001$). The differences in the gains between the groups during the research periods, i.e. since 1st up to 21st, 21st to 35th and since 35th up to 70th day of life amounted to 19 g (11.73%), 33 g (15.0%) and 21 g (12.07%), respectively. From birth until weaning, the difference was equal to 24 g (14.63%) and up to the age of 10 weeks – 23 g (13.61%). The mean feed intake by the litter amounted to 15.62 kg, including the period after weaning when it was only 6.30 kg what may be considered as the basic reason for weak gains of the piglets from the both groups for the period of 5 weeks after weaning. The ratio of the changes for feed conversion and growth rate of the piglets H vs. L indicates the better by 10.5–16% utilization of the mixtures and by 12–20% better growth rate of the piglets H vs. L. The deaths in groups L and H amounted to 15.44 and 6.7%, respectively, what indicates the unfavourable effect of the lowered body weight at birth on survivability of the piglets.

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Streszczenie: *Wpływ masy ciała prosiąt przy urodzeniu na ich odchów do wieku 10 tygodni*. Celem pracy była ocena wpływu masy ciała prosiąt przy urodzeniu na ich produkcyjność i przeżywalność do wieku 10 tygodni. Obserwacjami objęto prosięta urodzone przez 11 loch F1 rasy wielka biała polska × polska biała zwisłoucha inseminowanych nasieniem knurów (duroc × pietrain). Prosięta ważono w 1., 21., 35. i 70. dniu, kontrolowano pobranie paszy (na miot). Prosięta w zależności od masy ciała przy urodzeniu podzielono na grupy: lekkie (L) <1,5 kg (n = 52), ciężkie (H) ≥1,5 kg (n = 60). Średnia masa ciała wszystkich prosiąt w 1., 21., 35., i 70. dniu wyniosła: 1,45; 5,09; 7,70; 14,18 kg, a w grupach odpowiednio: L – 1,17; 4,58; 6,91; 13,00 kg oraz H – 1–70; 5–51; 8–29; 15–12 kg (L–H, P ≤ 0,001). Upadki prosiąt grup L i H wyniosły 15–4 i 6–7%. Przy swobodnym dostępie potomstwa do pokarmu matki i paszy stałej uzyskane wyniki wskazują, że gorsza produkcyjność wyrażona słabszym o 10,5–16% wykorzystaniem paszy, wolniejszym o 12–20% tempem wzrostu oraz obniżoną o 8,7 punktu procentowego przeżywalnością prosiąt z grupy L względem grupy H, były efektem znacząco mniejszej w stosunku do średniej masy ciała nowonarodzonych prosiąt.

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