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ANALYSIS OF SOME FACTORS INFLUENCING THE BIRTH WEIGHT OF PIGLETS

M. ČECHOVÁ

Mendel University of Agriculture and Forestry Brno, Czech Republic

ABSTRACT

Effects of a hybrid combination, sex, parity and number of all piglets born per litter on the individual birth weight of piglets were studied in a commercial herd of pigs. Experiments were performed using four hybrid combinations: cross-bred sows (Czech Large White x Czech Landrace) were artificially inseminated with sement of boars of the following breeds and hybrid combinations: Czech Large White - sire line, Duroc, (Duroc x Hampshire), (Pietrain x Hampshire). Individual weights of piglets were recorded at birth together with their sex, number of piglets per litter and the rank of parity. Altogether 960 piglets were weighed and their average birth weight was 1258 grams. Results were evaluated using the unifactorial variance analysis. As compared with other three combinations, piglets of the hybrid combination (CLW x CL) x CLW - sire line showed the highest average birth weight (1339 g); this difference was statistically highly significant ($P \leq 0.01$). A statistically highly significant difference ($P \leq 0.01$) existed also between birth weights of male and females. The effect of parity rank on the birth weight of piglets was also highly significant. A positive trend in birth weights of piglets with the increasing rank of parity. Birth weights increased gradually from the first parity (1247 g), culminated on the 5th parity (1337 g) and thereafter gradually decreased to 1111 g on the 10th parity. When evaluating the effect of the total number of all piglets born per litter on the birth weight it was found out that the heaviest piglets were in a litter with three piglets while the lightest ones were in the most numerous litter with 16 piglets (1169 g). Basing on values calculated for interactions of the 2nd degree of the four-factorial variance analysis it was concluded that the most significant was the interactions between the hybrid combination and the parity, the hybrid combination and the number of all piglets born per litter and between the parity and the number of all piglets born per litter. The correlation existing between the birth weight and the number of all piglets born per litter ($r = 0.0004$), combinations, sex were low but significant.

Key words: piglets, birth weight, hybrid combination, parity, sex, number of all piglets born

INTRODUCTION

A sufficient number of quality piglets is one of the basic preconditions of a successful production of final slaughter pig hybrids. From the viewpoint of reproduction traits, however, only the numbers of piglets born are not sufficient. Economically significant is the survival of piglets but a direct selection based on this trait is inefficient due to a low heritability of this trait (Čeřovský and Vinter, 1990). An acceptable alternative seems to be indirect selection for survival, i.e. selection based on individual birth weight of piglets. According to Hammerer (2000) as far as the survival of piglets is concerned, their optimum birth weight should be within the range of 1.6 - 1.8 kg. Schmidt (2002) mentioned that two thirds of all losses were associated with a low birth weight of piglets. Under practical conditions there is a broad range of birth weights of piglets and there are naturally also many various causes of these differences. Rohe and Kalm (1997) found out that an increase of litter size from 9 to 14 piglets was associated with a decrease in their average birth weight from 1.6 to 1.4 kg. Říha et al. (2001), who also studied correlations existing between the number of piglets born and their weight, considered for an optimum the birth weight of at least 1.60 kg. Bazala (1999) mentioned as an optimum birth weights ranging from 1.2 to 1.5 kg and Herčík (2003) recommended that, as far as the intensity of growth and viability of piglets were concerned, the birth weight should not be lower than 1.2 kg. Quiniou et al. (2002) analysed differences

Correspondence: E-mail: cechova@mendelu.cz

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correlations existing between the litter size and body weight of piglets in altogether 965 litters and found out that with the increasing number of piglets from 11 to 16 their birth weight decreased from 1.59 to 1.26 kg. Kyriazakis (1999), as well, studied the effect of litter size on the weight of newborn piglets and observed that only 44 % of piglets with the birth weight below 1 kg were able to survive till weaning. Herčík (2003) recorded the highest average birth weight in litters with only seven piglets (viz. 1.64 kg) and wrote that with the increasing litter size the birth weight decreased. Malligan et al. (2000) found out in litters with great differences in the birth weight the highest losses occurred mainly among lighter piglets. However, their growth rate was not negatively influenced by this fact.

Pour (1980) published results of his studies on birth weight differences among hybrid combinations (Large White x Přeštice Black-Pied) x Hampshire and (Large White x Přeštice Black-Pied) x Landrace. As compared with the progeny of Landrace boars, higher birth and weaning weights in 28 days were observed in the progeny of Hampshire sires (1.55 kg vs. 1.49 kg and 6.12 kg vs. 5.82 kg, resp.). Malligan et al., 2002 studied other effects that can influence the birth weight of piglets and found out that the heaviest progeny was born in the second litter. Matoušek et al. (2002), who also advise on influence of environmental conditions.

Buchová et al. (2000) mentioned that the birth weight of males was a little higher than that of females. A similar difference was reflected also in average daily gains of young boars within the period from the birth to weaning.

MATERIAL AND METHODS

The experiment focused on effects of some selected factors on individual birth weights of newborn piglets was established in a commercial herd. Cross-bred sows (Czech Large White x Czech Landrace) were artificially inseminated with semen of boars of the following breeds and hybrid combinations: Czech Large White - sire line (CLW - sire line), Duroc (D), Duroc x Hampshire (D x H), and Pietrain x Hampshire (Pn x H).

In the following text these combinations are mentioned as follows:

(CLW x CL) x CLW – sire line… A
(CLW x CL) x D………………… B
(CLW x CL) x (D x H) ..………… C
(CLW x CL) x (Pn x H) ………… D

Sows were kept in groups and fed on a complete feed mixture for pregnant sows (KPB) containing 6.6 g of lysine and 12.6 MJ ME/kg. One week before the parturition all sows were transferred into a farrowing house. After the birth all living piglets were individually weighed with the accuracy of 100 g and divided into groups according to their sex. In the following text males and females are mentioned as groups 1 and 2. Recorded were also the parity number and the size of individual litters (i.e. the number of all piglets born).

Effects of individual factors under study, i.e. hybrid combination, sex, parity and litter size were statistically evaluated using the model of unifactorial variance analysis:

$$y_{ij} = \mu + a_i + e_{ij}$$

where
μ – the average value of the factor under study
a_i – effect of i^{th} factor and
e_{ij} – residual component.

The significance of differences was analysed using Tukey test.

A multifactorial variance analysis was used to evaluate the effect of factors under study on the overall phenotypic variability of the birth weight of piglets.

$$y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

where
μ – the average value of the factor under study
a_i – effect of ith combination
b_j – effect of jth sex
c_k – effect of of kth parity
d_l – effect of lth number of all piglets per litter
e_{ijklm} – residual component.

For the statistical analysis the UNISTAT programme was used.

RESULTS AND DISCUSSION

Factors influencing the phenotypic variability of the birth weight of piglets in commercial herds were analysed using in a set of 960 piglets of four different hybrid combinations mentioned above. In the experimental set of piglets the average birth weight was 1258 g. The basic statistical characteristics of the trait under study as recorded for individual hybrid combinations are presented in Tab. 1. It was found out when evaluating individual birth weights that the highest and the lowest average birth weights occurred in hybrid combinations (CLW x CL) x CLW – sire line and (CLW x CL) x (D x H), viz. 1339 g and 1227 g, respectively. The variability of this trait was approximately the same in all hybrid combinations and ranged from 24.8 % to 28.6 %. These data corresponded with results published by Bazala (1999) and Herčík (2003) who recommended that the minimum birth weight of piglets should be 1200 g. On the other hand, however, Říha et al. (2001) and Hammerer (2000) mentioned the optimum birth weight of 1600 g.

Table 1: Basic statistical characteristics of birth
$s_{\bar{x}}$ **eights of individual hybrid combinations**
$v_{\bar{x}}$ **of piglets**

Combination	A	B	C	D	Total
n	166	276	267	251	960
$\bar{x}$	1339[a,b,c]	1244[a]	1227[b]	1255[c]	1258
	383	308	324	359	342
	0.286	0.248	0.264	0.286	0.272

a, b, c : P ≤ 0.01

Results of variance analysis (Tab. 2) indicate that the differences between individual hybrid combinations were statistically highly significant (P ≤ 0.01) and Tukey test demonstrated highly significant differences (P ≤ 0.01) between combinations A : B, C, D. In other cases the differences between these combinations were not significant. Pour (1980) recorded a higher birth weight (1550 g) in the hybrid combination (CLW x CL) x H.

Table 2: Variance analysis of a simple classification of the parameter birth weight in individual hybrid combinations

Source of variability	Sum of squares	St. vol.	Mean square	Stat F	Significance
Hybrid combination	1.398	3	0.466	4.016	0.0075
Error	110.935	956	0.116		
Total	112.333	959	0.117		

The effect of sex on the birth weight was analysed as well. The basic statistical characteristics calculated for males and females divided into groups according to individual hybrid combinations are presented in Tab. 3. The average birth weights of final hybrids were, regardless to individual interbreed birth weight, 1292 g and 1222 g for males and females, respectively. The test of differences in birth weights of males and females within the whole set of piglets revealed a statistically significant difference (P ≤ 0.01). As compared with females, higher birth weights of males were observed also when evaluating individual hybrid combinations A, B, C and D (1374 g; 1249 g; 1298 g and 1267 g vs. 1288 g; 1239 g; 1150 g; 1241 g, resp.). A statistically significant difference (P ≤ 0.01) between both sexes was found out only in the hybrid combination (CLW x CL) x (D x H). Similar results were published also by Buchová et al. (2000) who recorded higher birth weights of males (1450 g vs. 1400 g). However, the difference in birth weights of males and females was statistically insignificant.

The effect of parity on basic statistical characteristics of birth weights regardless to hybrid combinations are presented in Tab. 5. In our experimental group the maximum number of litters per sow was ten and the average values indicate a positive trend in birth weights of piglets with the increasing rank of parity. Birth weights culminated on the 5th parity (1337 g) and thereafter gradually decreased to 1111 g on the 10th parity. These analytical results are important from the viewpoint of optimisation of culling rate. Basing on these average data it is possible to conclude that the optimum number of parities is six. On the other side Malligan et al. (2002) observed the highest birth weights in piglets originating from second litters.

Table 3: Basic statistical characteristics of birth weights of both sexes in individual hybrid combinations of piglets

	A × 1	A × 2	B × 1	B × 2	C × 1	C × 2	D × 1	D × 2	Males	Females
n	97	69	129	147	138	129	136	115	500	460
$\bar{x}$	1374	1288	1249	1239	1298[a]	1150[a]	1267	1241	1292[b]	1222[b]
$s_{\bar{x}}$	363	403	302	313	339	289	352	367	342	340
$v_{\bar{x}}$	0.264	0.313	0.242	0.252	0.261	0.251	0.278	0.296	0.265	0.278

a, b = P ≤ 0.01

Table 4: Variance analysis of a simple classification of the parameter birth weight in both sexes

Source of variability	Sum of squares	St. vol.	Mean square	Stat F	Significance
Sex	1.155	1	1.155	9.951	0.0017
Error	111.179	958	0.116		
Total	112.333	959	0.117		

Table 5: Basic statistical characteristics of birth weights as dependent on the parity

Parity	1	2	3	4	5	6	7	8	9	10
n	197	185	102	133	168	41	57	53	15	9
$\bar{x}$	1247	1248^{a}	1187^{b}	1314	$1337^{a,b}$	1227	1188	1219	1233	1111
$s_{\bar{x}}$	316	391	295	317	351	351	363	300	262	213
$v_{\bar{x}}$	0.254	0.313	0.249	0.241	0.263	0.286	0.306	0.246	0.213	0.192

a : $P \leq 0.05$ b : $P \leq 0.01$

Table 6: Variance analysis of a simple classification of the parameter birth weight as dependent on the parity rank

Source of variability	Sum of squares	St. vol.	Mean square	Stat F	Significance
Parity rank	2.615	9	0.291	2.516	0.0075
Error	109.718	950	0.115		
Total	112.333	959	0.117		

Table 7: Basic statistical characteristics of birth weights as dependent on the number of all piglets born per litter

Number of all piglets born	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
n	3	8	35	24	28	56	81	160	154	144	143	56	75	16	17
$\bar{x}$	1800	1600	1512	1655	1564	1475	1319	1205	1146	1214	1187	1133	1174	1169	1688
$s_{\bar{x}}$	82	394	270	239	226	424	288	288	322	292	316	336	343	177	250
$v_{\bar{x}}$	0.045	0.246	0.178	0.144	0.144	0.288	0.218	0.239	0.281	0.24	0.266	0.297	0.292	0.151	0.148

Table 8. Variance analysis of a simple classification of the parameter birth weight as dependent on the number of all piglets born per litter

Source of variability	Sum of squares	St. vol.	Mean square	Stat F	Significance
All piglets born	5.740	14	0.410	3.635	0.0000
Error	106.593	945	0.113		
Total	112.333	956	0.117		

Table 9. Significance of the dependence of average birth weight of piglets on the number of all piglets born per litter

Number of all piglets born		9	10	11	12	13	14	15	16	17
	$\bar{x}$									
3	1800	**	*	*	*	*	*	*		
4	1600	_	**	**	**	**	**	**		
5	1512	**	***	***	***	***	***	***	*	
6	1655	***	***	***	***	***	***	***	***	
7	1564	***	***	***	***	***	***	***	**	
8	1475	**	***	***	***	***	***	***	*	
9	1319	_	*	***	*	*	*	*	_	***
10, 11, 12, 13, 14, 15, 16	.									***

* : $P \leq 0.05$; ** : $P \leq 0.01$; *** : $P \leq 0.001$

Table 10: Variance analysis of a multiple classification (four factors)

Source of variability	Sum of squares	St. vol.	Mean square	Stat F	Significance
Main effects	26.736	27	0.990	14.167	0.0000
Hybrid combination	2.226	3	0.742	10.616	0.0000
Sex	0.875	1	0.875	12.517	0.0004
Parity rank	3.065	9	0.341	4.873	0.0000
All piglets born	21.523	14	1.537	21.995	0.0000
Interaction of the 2nd degree	26.967	88	0.306	4.384	0.0000
Hybrid comb. × Sex	0.688	3	0.229	3.279	0.0205
Hybrid comb. × Parity rank	8.367	19	0.440	6.300	0.0000
Comb. × All piglets born	12.191	22	0.554	7.928	0.0000
Sex × Parity	1.233	9	0.137	1.959	0.0412
Sex × All piglets born	0.726	13	0.056	0.799	0.6615
Parity × All piglets born	6.778	22	0.308	4.408	0.0000
Explained	57.604	176	0.327	4.683	0.0000
Error	54.729	783	0.070		
Total	112.333	956	0.117		

Table 11: Correlation between studied traits

Trait	Birth weight	Sex	Parity rank	All piglets born
Hybrid combination	-0.1088***	0.0059	0.0482	0.0005
Birth weight		-0.0874*	-0.0290	-0.2772***
Sex			0.0094	0.0004
Parity rank				-0.0290

* : $P \leq 0.05$; ** : $P \leq 0.01$; *** : $P \leq 0.001$

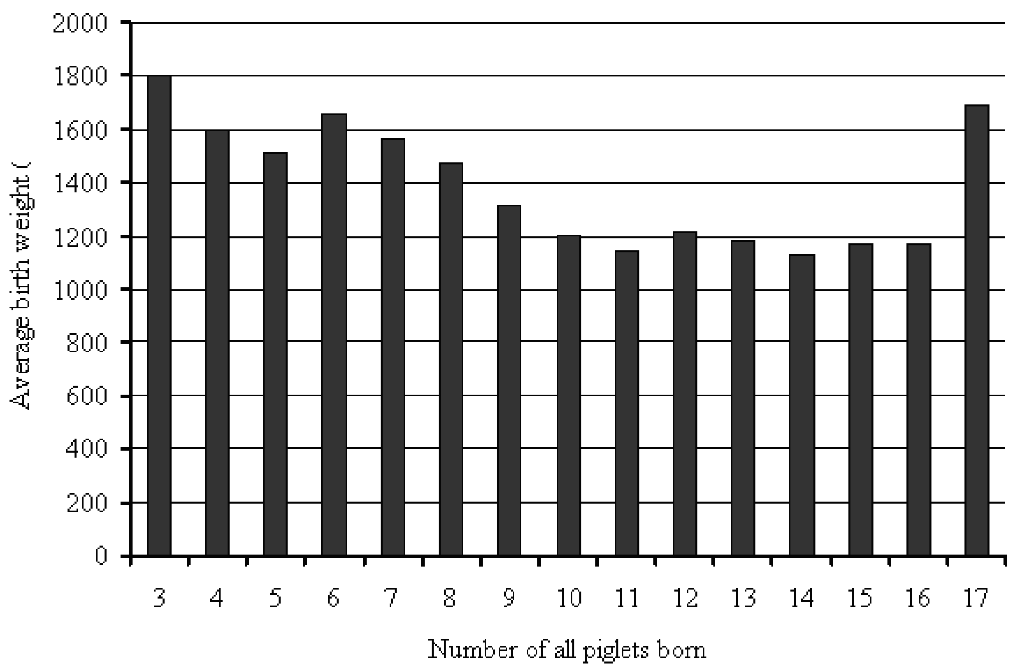

Fig. 1: A graphical presentation of average birth weights as dependent on the number of all piglets born

Finally, the effect of the number of all piglets born per litter on their average birth weights was analysed as wells. The basic statistical characteristics of this analysis are presented in Tab. 7. The birth weight of piglets decreased with the increasing number of all piglets born (Fig. 1). The highest average birth weight (1800 g) was recorded in a litter with 3 piglets only. In litters with increasing numbers of piglets the birth weight gradually decreased and in the most numerous one (16 piglets) it was only 1169 g. A litter with 17 piglets and the average birth weight 1688 g was regarded as atypical. This finding corresponded with data published by Rohe and Kalm (1997). Quinin et al. (2002), as well, observed that the birth weight a decreased with the increasing numbers of piglets per litter. The effect of the number of all piglets born on their birth weight was highly significant ($P \leq 0.001$). The significance of differences between individual groups of piglets is presented in Tab. 8. For the sake of a better transparency the cases with insignificant differences are not presented in this table.

Results of variance analysis of a multiple classification are presented in Tab. 10. Basing on values calculated for interactions of the 2nd degree of the four-factorial variance analysis it was concluded that the most significant was the interactions between the hybrid combination and the parity, the hybrid combination and the number of all piglets born per litter and between the parity and the number of all piglets born per litter. The correlation existing between the birth weight and the number of all piglets born per litter ($r = 0.0004$), combinations, sex were low but significant.

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Author´s address: Doc. Ing. Marie Čechová, CSc., Mendelova zemědělská a lesnická univerzita v Brně, Ústav chovu zvířat, Zemědělská 1, 613 00 Brno, Česká republika

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HISTOLOGICKÉ A HISTOCHEMICKÉ HODNOTENIE SVALOVÉHO TKANIVA HUSÍ

Histological and histochemical evalution of geese muscle tissue

S. MINDEK, Z. ELIÁŠ, J. WEIS, C. HRNČÁR

Slovenská poľnohospodárska univerzita, Nitra; Slovak Agricultiral University, Nitra, Slovak Republic

ABSTRACT

The aim of this study was to investigate histological structure of goose muscle tissue in geese originating from breeding farm in Tešedíkovo (south-western region of the Slovak Republic). The abundance and thickness of muscle fibres, abundance of adipose and connective tissue and correlations between these indicators were evaluated. Twenty 16-week-old geese with live weight of 5.28 kg were used in experiment. Animals were raised on geese breeding farm at the same conditions. Samples for histochemical analysis were taken from *musculus pectoralis major* and *musculus biceps femoris* within 30 minutes after slaughtering and immediately frozen in liquid nitrogen, subsequently histochemically processed. The 10 – 15 µm slices were chopped on minicryostat instrument. Sections were coloured by hematoxilin-eozin, oil-red and individual types of muscle fibres were differentiated according to the reaction with succinate-dehydrogenase. For histological structure analysis of listed muscles, microscope Nikon connected with software Lucia were used. From obtained data were calculated statistical indicators. In *m. pectoralis major* the highest percentual abundance of white muscle fibres (48.53 %) and the lowest abundance of intermediate muscle fibres (1.93 %) were obtained. The same tendency of abundance of different types of muscle fibres was obtained in *m. pectoralis femoris* (white muscle fibres – 56.77 %, intermediate muscle fibres – 2.03 %). In *m. biceps femoralis* the highest values of white muscle fibre thickness and the lowest values of red muscle fibre thickness were obtained. Similarly in *m. biceps femoralis* the highest values of white muscle fibres and the lowest values of red muscle fibres were obtained, while average thickness of red muscle fibres in *m. pectoralis major* was lower by 22.99 µm in comparison with red muscle fiber thickness in *m. biceps femoralis*. Higher abundance of connective tissue than fat tissue was obtained in both muscles, while *biceps femoris* had just nearly half values of fat tissue abundance in pectoralis muscle. In fat cell diameter there were no significant differences between muscles. Significant negative correlation between white and red muscle fibre abundance in both muscles was obtained. In femoris muscle significant negative correlation between white muscle fibre and tissue abundance and positive correlation between white muscle fibre diameter and live weight of geese was obtained.

Keywords: geese, Tesedik geese, muscle fibers, m. pectoralis major, m. biceps, femoris, adipose tissue

ÚVOD

Produkcia a spotreba hydinového mäsa postupne narastá nielen u nás ale aj vo svete. Aj keď najvyšší podiel na spotrebe hydinového mäsa má kuracie mäso, zanedbateľná nie je ani produkcia husí.

Svalová sústava tvorí aktívnu časť pohybovej sústavy, ktorá hýbe jej pasívnou zložkou – kostrou. Priečne pruhované kostrové svalstvo tvorí podstatnú časť celého svalového systému a najväčšou mierou sa podieľa na produkcii mäsa hospodárskych zvierat. Kostrový sval sa skladá zo svalových vlákien, väziva, ciev, nervového a tukového tkaniva (Larzul a kol.1997).

Sval ako taký je uzavretý vo vrstve spojivového tkaniva nazývaného epimýzium, ktoré je zložené prevažne z kolagénu. Jednotlivé svalové vlákna sú obalené spojivovým tkanivom nazývaným endomýzium, ktoré predstavuje sieť spojivového tkaniva odstupujúceho od

Correspondence: E-mail: slavomir.mindek@uniag.sk