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INTERRELATIONS OF POTENTIAL AND ACTUAL FERTILITY WITH GLYCOGEN CONTENT IN *CORPUS LUTEUM GRAVIDITATIS* OF LANDRACE AND LARGE WHITE GILTS

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Abstract

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An analysis of the dependence between the relative content of glycogen in Corpus luteum in the course of gestation and the parameters of potential and actual fertility of gilts from the breeds Landrace and Large White was carried out. The evaluation of the correlations between the mentioned indices in the tested animals (91 Landrace and 99 Large White) was carried out on the 25th, 35th, 55th, 75th, 95th and 110th day of gestation respectively. For the characteristic of ovulation rate or potential fertility the number of Corpus luteum was used, while actual fertility was determined by the number of normally developed fetuses. A considerable increase of glycogen content in Corpus luteum is observed up to 75th day, followed by a significant decrease of the average level until the end of gestation. The coefficients of correlation between the number of fetuses and glycogen content in Corpus luteum up to the 75th day are positive, reliable and practically the same for the two experimental breeds. The total evaluations of the interrelation between potential fertility and actual fertility and of the multiple influences of the ovulation rate and glycogen content in Corpus luteum on the number of fetuses are relatively more significant in Landrace gilts. Characteristic peculiarities of the examined correlations are registered depending on the breed of the boars used for fertilization; as a very significant influence is noticed in respect to the coefficients of the analyzed multiple correlation in Large White.

Key words: glycogen in Corpus luteum, potential fertility, actual fertility, Landrace and Large White gilts

Introduction

The final indices of the actual fertility of the litter-bearing species of animals are formed as integral result from the action of the whole complex of interrelated determining factors (Misik and Netesa, 1994; Jelev, 1998; Boychev, 2014). In the course of the decisive concluding stage of the reproductive process a fundamental place between them is taken by corpora lutea. By means of its active hormonal secretion Corpus luteum graviditatis performs the role of one of the basic regulational mechanisms for the maintenance of pregnancy of gilts (Dziuk, 1987; Semkov et al., 2011). In the same time the specific functional resources of Corpus luteum are closely connected to the complex morpho-physiological parameters of the luteal tissue and its characteristic metabolitic status (Boychev et al., 1996, 1998, 1999; Semkov et al., 2011).

As a basic carbohydrate reserve, the glycogen participates directly in the energetic securing of the inner cell processes and its balance in the framework of some tissues is relatively well studied. The content of glycogen is investigated in the placenta of laboratory animals and sows, in the uterus muscles, in the liver and in the lung of fetuses and pigs (Kolushev and Boychev, 2003). However, in scientific literature, there is no data for the level of the discussed parameter in Corpus luteum at the different stages of gestation.

On the other hand, in a set of articles concretely over sows, the dependence between the hormonal activity and

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the number of Corpus luteum is analyzed, the interrelation between the quantity of progesterone and the parameters of the embryonal and fetal survival is researched, differences in the ovulation rate and respectively the average number of the obtained offspring between the different breeds are registered (Felder et al., 1987; Boychev and Kolushev, 1993; Boychev, 2014).

The aim of this study included the evaluation of the dependencies between the content of glycogen in corpora lutea and the indices of the potential and actual fertility in gestation of gilts from different breeds.

Materials and Methods

The tested female animals from the breeds Landrace and Large White were fertilized by means of a double mating when they reached 105-110 kg live weight. The gestation was interrupted on the 25th, 35th, 55th, 75th, 95th and 110th day. After the opening of the abdominal cavity of gilts both ovaries and the respective Corpus luteum were separated.

The relative content of glycogen in Corpus luteum of the pregnant animals (91 Landrace and 99 Large White) was determined by means of a specific double hydrolysis of the luteal tissue with KOH and HC1 and following defining of the amount of glycogen (mg %) as glucose. The evaluation of the actual fertility was based upon the number of normally developed vital fetuses. For the characteristics of the ovulation rate and respectively of the potential fertility the number of Corpus luteum was used.

Results and Discussion

As it demonstrates a characteristic tendency toward a considerable increase after the 35th day of gestation, the glycogen content in Corpus luteum reaches its maximum level towards the 75th day after fertilization (Table 1). After this moment the level of the examined index rapidly decreases, marking immediately before parturition quantities smaller than these from the earliest investigated stages of gestation.

Table 1

In comparison with Large White in Landrace a tendency toward negligibly smaller maximum average level of the researched index was noted down (1.66 and 1.47 mg % respectively). The ovulation rate and the level of actual fertility are almost alike in animals from the two studied breeds and as a whole satisfactorily high as for gilts (Venev, 1982; Misik and Netesa, 1994; Boychev, 2014). Along the same lines the total parameters of the embrional and fetal survival of the experimental animals should be interpreted. Even for the stages immediately before parturation the average loss does not exceed 24% from the number of the ovulated follicles and respectively the registered Corpus luteum, while according to separate authors the discussed difference of actual fertility from potential fertility reaches 35-50% towards the end of gestation (Dziuk, 1987; Semkov et al., 2011).

The analysis of the correlations between glycogen content in Corpus luteum and the indices of potential fertility shows that in the framework of the separate stages, as well as in common for both breeds the corresponding coefficients are minimal and not proved (Table 2).

Table 1
Dynamics of glycogen content in *Corpus luteum* of Landrace and Large White gilts and parameters of potential and actual fertility

Breeds	Stage of pregnancy, days	Number of animals	Average values			Portion of actual from potential fertility, %
			Glycogen content, mg %	Corpus lutem, no.,	Fetuses, no.	
Landrace	25-35	27	0.81±0.07	15.5±0.5	12.5±0.6	80.8±2.4
	55-75	39	1.47±0.08	15.3±0.4	12.3±0.6	79.2±3.0
	95-110	25	0.62±0.05	14.6±0.5	11.0±0.5	76.0±2.6
	Total	91	1.04±0.06	15.2±0.3	12.0±0.3	78.8±1.6
Large White	25-35	30	0.83±0.06	15.2±0.5	12.1±0.5	80.3±3.1
	55-75	43	1.66±0.07	15.0±0.4	12.2±0.6	80.7±3.1
	95-110	26	0.66±0.05	16.2±0.6	12.1±0.4	76.3±2.3
	Total	99	1.14±0.06	15.4±0.3	12.1±0.3	79.4±1.7

The correlations between glycogen content and the number of fetuses are reliable, positive and significant up to the 75th day again in both populations. Together with the relatively a little bit more significant total evaluation of the above dependence in Landrace gilts the last also demonstrate a definitely more narrow total interrelation between the parameters of potential fertility and actual fertility actual fertility (0.74 in Landrace and 0.54 in Large White).

The evaluation of joint influence of glycogen content in Corpus luteum and ovulation rate on the resulting index "number of fetuses" by means of the coefficients of multiple correlation shows the highly significant and reliable character of this dependence in Landrace (0.82). Comparatively smaller, but also significant and statistically proved is the effect of the two indices over the actual fertility in Large White gilts (0.66).

Characteristic peculiarities in the average levels and ratios between the examined indices are registered depending on the breed of the used boars (Table 3). When gilts from the respective breed were mated with boars from the same one the average glycogen content in Corpus luteum is relatively lower than this in gilts, mated with boars from the alternative population. Independently from the breed of the gilts the pointed difference is not accumulated for the account of a separate period of gestation, but is observed as nearly constant proportional value at all investigated stages.

When Large White gilts were mated with Landrace boars the absolute difference between the average number of Corpus luteum and fetuses for the analyzed periods varies from 2.0 to 3.2 (average 2.7), while for mating Large White x Large White the deviations between potential fertility and actual fertility are pronouncedly more significant – from

Table 2
Coefficients of phenotypical correlations between glycogen content (1), number of *Corpus luteum* (2) and number of fetuses (3)

Breeds	Stage of pregnancy, days	Number of animals	Single correlations			Multiple correlations
			r_{12}	r_{13}	r_{23}	$R_{3.12}$
Landrace	25 - 35	27	+ 0.20	+ 0.57**	+ 0.77***	0.87***
	55 - 75	39	+ 0.21	+ 0.60***	+ 0.77***	0.89***
	95 - 110	25	- 0.06	+ 0.20	+ 0.68***	0.72***
	Total	91	+ 0.16	+ 0.46***	+ 0.74***	0.82***
Large White	25 - 35	30	- 0.01	+ 0.56**	+ 0.42*	0.70***
	55 - 75	43	+ 0.27	+0.58***	+0.66***	0.78***
	95 - 110	26	- 0.24	+ 0.14	+ 0.64***	0.70***
	Total	99	- 0.05	+ 0.35***	+ 0.54***	0.66***

*** - P < 0.001

Table 3
Variability of the content of glycogen (1), portion of actual fertility (3) from potential one (2) and coefficients of correlation in different methods of breeding (dam breed noticed first)

System of mating	Number of female animals	Content of glycogen in corpora lutea, mg % X ± Sx	Portion of actual from potential fertility, % X + Sx	Coefficients of correlation		
				r_{12}	r_{13}	$R_{3.12}$
Landrace x Landrace	43	0.91*±0.08	75.7±2,6	- 0.10	+ 0.37*	0.78***
Landrace X Large White	48	1.15*±0.08	81.6±2.2	+ 0.35*	+ 0.51***	0.84***
Large White X Large White	46	0.96**±0.08	75.9±2.9	- 0.24	+ 0.22	0.45**
Large White X Landrace	53	1.30**±0.08	82.5±2,0	+ 0.17	+ 0.44**	0.82***

*** - P< 0.001; ** - P<0.01; * - P< 0.05

3.5 to 5.0 (average 4.1). The picture of analogous differences for the corresponding schemes of mating of Landrace gilts is of very similar character. As a reflection of these peculiarities the common tendency towards higher average percent of the embryonal and fetal survival in cross-breeding is relatively well determined, but the differences although near to the reliable are not statistically proved.

When Landrace gilts were mated with Large White boars together with the positive correlation between the ovulation rate and glycogen content in Corpus luteum, a relatively more narrow dependence between the latter parameter and actual fertility is registered (0.51 vs. 0.37 for mating Landrace x Landrace). The difference of the evaluations of the single correlation potential fertility - actual fertility and the analyzed multiple correlation is identical with the above in mating Landrace x Landrace, while in cross-breeding with Large White the respective coefficients practically almost do not differ.

In comparison with purebred mating of Large White gilts, a definitely more significant reliable interrelation between actual fertility and glycogen content in Corpus luteum is noted down in cross-breeding Large White x Landrace. The differentiation of the complex total effect of the glycogen content in Corpus luteum and ovulation rate on actual fertility is peculiarly underlined in gilts from this breed. When the latter were mated with Landrace boars the respective coefficient of multiple correlations is almost twice higher (0.82, $p < 0.001$) from the analogous evaluation of the discussed dependence in purebred mating (0.45, $p < 0.01$).

Conclusions

The content of glycogen in Corpus luteum of gilts increases considerably up to 75th day of gestation, after which it rapidly falls down to levels lower than these in the beginning of gestation. Up to the 75th day the correlation between glycogen content and the number of fetuses is positive, considerable and reliable both in Large White and Landrace. In the latter relatively more substantial total evaluations of the interrelation between potential fertility and actual fertility as well as the multiple influence of glycogen content in Corpus luteum and ovulation rate on actual fertility are registered. When experimental gilts were mated with boars from the same or alternative breed some characteristic peculiarities of the researched correlations are marked. The differentiation of the coefficients of the analyzed multiple correlations in Large White gilts fertilized by boars from different breeds are highly significant.

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