

Short communication. Lactation performance of Duroc gilts under the single farrowing production system

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Abstract

Twelve Duroc gilts were used in order to study production and composition of milk during the lactation period and the litter performance under the single farrowing production system. Estrus was induced using PG-600 (400 IU of pregnant mare serum gonadotrophin + 200 IU of human chorionic gonadotrophin) and the females were artificially inseminated at 171 ± 6 d and 95.1 ± 5.6 kg live weight. Daily milk production was determined according to the weigh-suckle-weigh technique at 1, 7, 14 and 21 d of lactation and colostrum and mature milk samples were collected at farrowing and on 8, 15 and 22 d of lactation. The sows net gain during pregnancy was of 49.1 ± 7.1 kg and during lactation their feed intake was of 3.4 ± 0.3 kg d⁻¹ and their weight loss was 5.83 ± 2.5 kg. The production of milk increased in a linear way through the lactation period and the average daily production was very low (4.29 ± 0.7 kg). The contents of colostrum dry matter, gross energy and protein were higher than the mature milk but lower regarding fat and lactose. Dry matter, gross energy, protein and lactose contents in milk did not significantly vary during lactation. Nevertheless, an increase in fat content was found in the eighth day of lactation. The average daily gain in piglets was 130.4 ± 31.5 g and the milk conversion ratio was 3.47 ± 0.39 kg kg⁻¹. The protein level in lactation feed did not have a significant influence on sows and piglets performances.

Additional key words: milk composition, milk yield, piglet performance.

Resumen

Nota corta. Resultados de lactación de cerdas Duroc sometidas al sistema de producción a un solo parto

Se utilizaron doce cerdas Duroc, sometidas al sistema de producción a un solo parto, con objeto de estudiar la producción y composición de la leche y los índices productivos de los lechones. El estro fue inducido mediante PG-600 (400 UI de gonadotropina sérica de yegua gestante + 200 UI de gonadotropina coriónica humana) y las cerdas fueron inseminadas a los 171 ± 6 días con 91,1 ± 5,6 kg. La producción de leche fue estimada mediante la técnica de doble pesada de los lechones los días 1, 7, 14 y 21 de lactación y muestras de calostro y de leche fueron tomadas al parto y en los días 8, 15 y 22 de lactación. La ganancia neta de peso de las cerdas durante la gestación fue de 49,1 ± 7,1 kg y el consumo medio diario de pienso durante la lactación fue de 3,4 ± 0,3 kg y la pérdida de peso durante dicho período de 5,8 ± 2,5 kg. La producción media diaria de leche fue muy baja (4,29 ± 0,7 kg) durante la lactación, pero se incrementó linealmente desde el parto hasta el destete a los 21 días. Los contenidos de materia seca, energía bruta y proteína del calostro fueron superiores a los de la leche, mientras que los de grasa y lactosa fueron inferiores. Los contenidos de materia seca, energía bruta, proteína y lactosa de la leche no variaron significativamente durante la lactación, aunque se observó un aumento de la concentración de grasa el día octavo de amamantamiento. La ganancia media diaria de los lechones fue 130,4 ± 31,5 g y el índice de transformación de la leche 3,47 ± 0,39 kg kg⁻¹. El contenido de proteína bruta del pienso de lactación no afectó significativamente a los resultados productivos de las cerdas y de los lechones.

Palabras clave adicionales: cerda primípara, índices productivos de los lechones, producción y composición de la leche.

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The single farrowing production system in swine is based on the joint production of primiparous gilts and piglets or finishing pigs. This system involves premature breeding of the gilt, an early gestation diagnosis and a premature weaning of the piglets. The objective is to obtain finished gilts that provide the market with a carcass similar to the finishing pigs and therefore do not suffer reductions in sale price. This production system can be interesting for markets like the Spanish one where the consumption of pork elaborated meat products has special importance.

Several papers have been published on this production system regarding reproductive results, growth, feed: gain ratio, meat and carcass characteristics of early mated gilts (Friend *et al.*, 1979; Elliot *et al.*, 1982; Ellis *et al.*, 1996; Zbinden, 1998; Daza *et al.*, 2005). Nevertheless, the production and composition of milk and the variation in weight during the pregnancy and lactation of sows induced at puberty, before 6 months of age, and their piglet performance are aspects not well documented. Therefore, this paper studied the lactation performance of Duroc gilts under the single farrowing production system. We also took into consideration the response of the previous variables to an increase in the protein concentration of the lactation feed.

Twelve prepubertal Duroc gilts of 171.7 ± 6 days of age were induced to estrus by one injection of 400 IU of pregnant mare serum gonadotrophin + 200 IU of human chorionic gonadotrophin (PG-600, Intervet, Ltd) and inseminated at first symptoms of heat and 24 h later. All sows were housed in individual cages during pregnancy and received a daily ration of 2 kg of feed with 3.0 Mcal of ME (metabolizable energy) kg^{-1} , 140 g CP (crude protein) kg^{-1} and 5.4 g lysine kg^{-1} . During a lactation period of 21 days sows were housed in individual cages and fed *ad libitum*. One group of six sows received feed with 3,230 kcal of ME kg^{-1} , 170 g CP kg^{-1} and 12.0 lysine kg^{-1} and other group of six sows received another feed with an equal energy concentration as the first group but with 220 g of CP kg^{-1} and 12.6 g of lysine kg^{-1} . Litters were equalized with 10 piglets per sow on farrowing day in order to adopt the withdrawal-fostering piglets strategy between them and other primiparous sows of recent farrowing. During the lactation period of the 12 sows, 2 sows suckled 8 piglets, 2 sows 9 piglets and 8 suckled 10, the rest of the 6 piglets died during the three first days of lactation. During lactation, 3 or 4 fostered piglets suckled per sow.

Daily milk production was determined according to the weigh-suckle-weigh technique (Speer and Cox, 1984) on d1, d7, d14 and d21 of lactation. Twelve sucklings were measured with 60 min intervals between sucklings using an electronic balance with an integration system (precision: 1g). Milk production during the control days was corrected according to the methodology proposed by Noblet and Etienne (1986). The daily mean milk production per week was calculated from the average milk production on the first and last day of the week. The litter was removed from the sow for one hour to estimate the composition of colostrum and milk on the farrowing day and on days 8, 15 and 22 of the lactation period. Each sow received an injection of 10 IU of oxytocine and the available milk was removed from various teats. The samples obtained were frozen at -20°C and stored to determine dry matter (DM) (by drying at 87°C), gross energy (adiabatic calorimeter), crude protein (Kjeldahl), fat (Gerber) and lactose (HPLC method: Nollet, 1992). The daily mean of dry matter, energy, protein (nitrogen $\times 6.38$) fat and lactose productions per week were calculated considering the productions of the first and last day of each week.

Sows were weighed on service day, then after farrowing and after weaning. Feed intake was controlled throughout the lactation period.

Data were processed by different models of variance and covariance analysis of the GLM procedure of the SAS statistical package (SAS, 1999). A previous covariance analysis found that the protein level in lactation feed did not have a significant influence on sows' and piglets' performances. Consequently, lactation stage (day of lactation) was the factor considered for milk production and composition, whereas sow, lactation stage and piglet type (adopted vs own), introducing the piglet weight at birth and litter size as covariates, were the factors considered for piglets average daily gain and efficiency in milk conversion. The effects of gilt weight at farrowing, litter size and weight at birth and gilt weight loss and average daily feed intake during the lactation period on milk production were studied by mean simple linear regression. Simple linear regression was also used to study the relationships between milk production and litter and piglet growth and lactation stage.

The average weight of sows on service day was 95.1 ± 5.6 kg and during pregnancy their net gain was 49.1 ± 7.1 kg. The piglets born alive per sow were 6.92 ± 1.9 with a

birth weight of 1.24 ± 0.2 kg. The foster piglets weight at birth was 1.26 ± 0.1 kg. During the lactation period the number of piglets suckled per sow was 9.50 ± 0.76 .

The average daily intake of feed per sow during lactation was 3.40 ± 0.3 kg and weight loss per sow during the lactation period was 5.83 ± 2.5 kg.

The litter size was smaller than in other papers where puberty was induced by boar stimulus (Elliot *et al.*, 1982) or using oral allyl-trenbolone for 10 days followed on day 11 by an injection of PMSG and HCG (Ellis *et al.*, 1996). Sows weight gain from service to postpartum was similar to that reported by Friend *et al.* (1979), Elliot *et al.* (1982) and Daza *et al.* (2005) in sows that received a daily energy supplement during pregnancy equal to the sows in our experiment.

The average birth weight of piglets observed in our study was higher by 0.1 – 0.2 kg than that recorded in other experiments in which sows' prolificity was higher (Friend *et al.*, 1979; Elliot *et al.*, 1982). The average daily intake of feed by primiparous sows during lactation period observed in other experiments has been also very low (Coffey *et al.*, 1994; Neil *et al.*, 1996).

During the 21 days of lactation the average daily milk production was 4.29 ± 0.7 kg. In other experiments where the gilts were mated with greater age and weight (7-8 months and 100-125 kg) the average daily milk production was higher than in our experiment (Noblet and Etienne, 1986; King *et al.*, 1993; Daza *et al.*, 1999a).

The relationship between the sow average daily milk production (ADMP) and the variables sow weight at farrowing (WF), litter size (LS), litter weight at birth (LWB), sow weight loss (SWL) and average daily feed intake (ADFI) during lactation and lactation day (LD) are

Table 1. Regression equations on sow weight at farrowing (WF) (kg), number of piglets suckled per sow (LS), litter weight at birth (LWB) (kg), sow weight loss (SWL) (kg) and average daily feed intake (ADFI) (kg) during the lactation period and lactation day (LD) of the average daily milk production (ADMP) (kg)

Equation	R ²	Significance
ADMP = 4.71 – 0.00405 × WF	0.006	
ADMP = 2.30 + 0.19 × LS	0.34	*
ADMP = 2.15 + 0.158 × LWB	0.33	*
ADMP = 3.419 + 0.119 × SWL	0.40	*
ADMP = 8.90 – 1.406 × ADFI	0.46	*
ADMP = 1.59 + 0.251 LD	0.86	***

* P < 0.05, *** P < 0.001.

presented in Table 1. No significant effect of WF on ADMP was observed. However, the ADMP increased significantly (P < 0.05) with LS, LWB, SWL and LD and decreased significantly (P < 0.05) with ADFI. The sows' weight loss during the lactation period decreased as the ADFI increased according to the regression equation: SWL (kg) = 27.99 – 6.51 × ADFI (kg), R² = 0.36, P < 0.05. Most of these relationships are in agreement with those observed by Noblet *et al.* (1998) and Daza *et al.* (2005). The negative relationship observed between ADMP and ADFI might be due to the fact that maintaining the very young sows' body tissues had a higher priority than milk production. The primiparous sows have large bodily reserves (Gadd, 1987) and their milk production may be independent of the feed intake during the first lactation (O'Grady *et al.*, 1973).

Dry matter, gross energy and protein contents of the colostrum were significantly higher (P < 0.05) than those of mature milk. Nevertheless, the fat and lactose contents of the colostrum were significantly (P < 0.05) lower than those of mature milk (Table 2). On the eighth day of lactation, the fat content was significantly higher (P < 0.05) than on days 15 and 22 but the dry matter, gross energy, protein and lactose contents on days 8, 15 and 22 were not significantly different.

The protein, fat and lactose contents of the colostrum obtained in our experiment agree with those reported by Zou *et al.* (1992) in primiparous Yorkshire sows, but the protein content of mature milk was higher in our experiment. Similar to our results, higher concentrations of dry matter, gross energy and crude protein and lower concentrations of fat and lactose were found in colostrum when compared to mature milk (Klobasa *et al.*, 1987; Volpelli *et al.*, 1991; Zou *et al.*, 1992). In some experiments with mature milk a significant reduction in fat and crude protein contents and an increase in lactose have been observed as the lactation period progressed (Noblet and Etienne, 1986; Zou *et al.*, 1992). These changes, nevertheless, were not observed in other experiments (Klobasa *et al.*, 1987; Rodgers and Alston-Mills, 1990; Volpelli *et al.*, 1991; Hodbod and Zeman, 2001).

In this experiment it was observed that an increase in the protein level (22% vs 17%) in isocaloric lactation diets containing the same lysine concentration did not affect milk production and composition and the piglets' performance. These results agree with those reported by King *et al.* (1993), Hurley and Bryson (1999) and Sinclair *et al.* (1999).

Table 2. Changes in the production and composition of milk during lactation

Item	Day of lactation			
	1 ¹ (colostrum)	7	14	21
Milk production (kg)	1.82 ± 0.2 ^a	3.20 ± 0.2 ^b	5.42 ± 0.42 ^c	6.69 ± 0.2 ^d
Milk composition ²				
Dry matter (g kg ⁻¹)	235.2 ± 11.2 ^a	190.3 ± 8.5 ^b	184.7 ± 5.2 ^b	182.0 ± 7.7 ^b
Protein (g kg ⁻¹)	144.1 ± 7.2 ^a	57.1 ± 5.2 ^b	56.0 ± 5.8 ^b	54.2 ± 8.2 ^b
Fat (g kg ⁻¹)	52.1 ± 4.1 ^a	76.5 ± 2.3 ^b	66.2 ± 2.3 ^c	60.1 ± 4.8 ^c
Lactose (g kg ⁻¹)	31.0 ± 3.2 ^a	53.2 ± 2.8 ^b	52.4 ± 2.8 ^b	56.3 ± 3.7 ^b
Gross energy (kcal kg ⁻¹)	1431.3 ± 50.0 ^a	1234.5 ± 31.7 ^b	1153.4 ± 31.4 ^b	1131.9 ± 48.2 ^b

¹ Day 1: samples were collected within the first 12 h after birth of the first piglet. Means with different superscripts differed ($P < 0.05$). ² Days 1, 8, 15 and 22 of lactation.

Table 3. Changes in the average daily gain and milk conversion efficiency of piglets during lactation¹

Item	Week of lactation		
	1	2	3
Average daily gain (g)	105.8 ± 22.1 ^a	166.7 ± 29.2 ^b	120.8 ± 18.3 ^c
Milk conversion			
Milk (kg kg ⁻¹)	2.54 ± 0.26 ^a	2.80 ± 0.23 ^b	5.52 ± 1.25 ^c
Dry matter (kg kg ⁻¹)	0.54 ± 0.07 ^a	0.52 ± 0.05 ^a	1.01 ± 0.21 ^b
Gross energy (kcal g ⁻¹)	3.38 ± 0.27 ^a	3.34 ± 0.29 ^a	6.31 ± 1.28 ^b

¹ Least square means ± standard error. Means with different superscripts differed ($P < 0.05$).

The average daily gain of piglets was 130.4 ± 31.5 g which increased significantly with the birth weight of piglets and with the reduction in litter size ($P < 0.01$). The milk conversion ratio was 3.47 ± 0.39 kg kg⁻¹ (4.15 ± 0.28 kcal g⁻¹) and this tended to increase with litter size ($P < 0.06$). Milk intake per kg of weight gain in 21 days of lactation was a little lower than the results obtained by White and Campbell (1984) and Noblet and Etienne (1986). In these experiments, piglets reached a higher weight at 21 days of age than in our experiment, and therefore, probably started to synthesize body fat at earlier ages. Evolution of the weekly average daily growth and of the milk conversion ratio are detailed in Table 3. The average daily gain increased during the first two weeks of lactation and decreased during the third. The conversion ratio of milk increased significantly ($P < 0.05$) together with the lactation progress, although when these variables were expressed as kg of dry

matter per kg of weight increase or as kcal of gross energy consumed per kg of weight increase, they did not vary significantly until the third week of lactation. The increase in maintenance requirements and the decrease in water content of the weight increase according to an increase in age and weight results in an increased energy intake for kg of weight gain during development of the lactation period (Van Kempen *et al.*, 1985; Noblet and Etienne, 1989; Daza *et al.*, 1999b). No significant effect of piglet type (own compared to adopted) on piglet performance was observed. This result has been reported in previous experiments (Price *et al.*, 1994; Daza *et al.*, 2005). The interaction between sows and own or adopted piglets for the growth and conversion ratio of milk during the lactation period were not significant. This finding agrees with that reported by Daza *et al.* (2005). However, the gilt had a significant ($P < 0.05$) influence on the piglets' performance.

As expected, the average daily gain in litter (LADG) and piglet (PADG) increased linearly with the increase in ADMP and average daily milk production per weaned piglet (ADMPWP) respectively according to the regression equations:

$$\text{LADG (g)} = 633.3 + 141.9 \times \text{ADMP (kg)}, \\ R^2 = 0.57, P < 0.01.$$

$$\text{PADG (g)} = 57.1 + 156.44 \text{ ADMPWP (kg)}, \\ R^2 = 0.56, P < 0.01.$$

It is concluded that premature breeding of gilts leads to a low milk production and poor performance of the piglets. A delay in first-time breeding would probably improve these results.

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