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Short communication. Changes in the composition of sows' milk between days 5 to 26 of lactation

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Abstract

Ten Large White x Landrace sows were used to measure changes during lactation of composition of the milk. Milk composition on day 5, 12, 19 and 26 of lactation included 195.7, 192.2, 185.4 and 184.1 g of dry matter kg^{-1}, 59.3, 55.8, 55.1 and 54.8 g of crude protein kg^{-1} and 1.3, 1.18, 1.16 and 1.17 Mcal of gross energy kg^{-1}, respectively. Dry matter, crude protein and gross energy levels in the milk did not vary significantly with stage of lactation. Amino acids average total (except tryptophan, proline and cystine) and lysine average contents of sows milk on day 5, 12, 19, and 26 after parturition were 73.5, 77.6, 82.7 and 81.8 g/100 g milk protein and 5.97, 6.41, 7.05 and 6.81 g/100 g milk protein, respectively. All studied amino acids with some exceptions (methionine, threonine, histidine and glycine) varied significantly ($P < 0.05$) its concentration with stage of lactation. The concentration change of some amino acids (lysine, leucine, valine and glutamic acid) found in our experiment could be ascribed to the change, throughout lactation, of the ratio of casein to whey proteins in the milk.

Key words: Large White x Landrace, milk, constituents, evolution.

Resumen

Nota corta. Variación de la composición de la leche de cerda entre los días 5 y 26 de lactación

Se han utilizado 10 cerdas Landrace x Large White con el fin de estudiar la evolución de la composición de la leche durante la lactación. Los contenidos de materia seca, proteína bruta y energía bruta obtenidos los días 5, 12, 19 y 26 de lactación fueron 195,7, 192,2, 185,4 y 184,1g kg^{-1}; 59,3, 55,8, 55,1 y 54,8g kg^{-1} y 1,30, 1,18, 1,16 y 1,17 Mcal kg^{-1} respectivamente. Las concentraciones de materia seca, proteína bruta y energía bruta no variaron significativamente durante el periodo de lactación. El contenido en aminoácidos totales (excepto triptófano, prolina y cistina) fue 73,5, 77,6, 82,7 y 81,8 g/100 g de proteína en los días 5, 12, 19 y 26 de lactación respectivamente, siendo las concentraciones de lisina, en los días de control precitados, 5,97, 6,41, 7,05 y 6,81 g/100 g de proteína respectivamente. El contenido de todos los aminoácidos estudiados, salvo algunas excepciones (metionina, treonina, histidina y glicina), variaron significativamente ($P < 0,05$) durante el periodo de lactación. La variación encontrada, a lo largo de la lactación, de la concentración de algunos aminoácidos (lisina, leucina, valina y ácido glutámico) puede ser atribuida a la variación de la relación entre la caseína y las proteínas del suero durante dicho periodo.

Palabras clave: Large White x Landrace, leche, constituyentes, evolución.

The composition of sows' milk changes throughout lactation is a theme of particular interest to understand the nutritional requirements of the lactating sow.

Some experiments have been carried out to study the evolution of the major constituents of sows' milk (Klobasa *et al*., 1987; Rodgers and Alston-Mills, 1990). Other trials have examined the influence on composition of various factors such as breed (Zou *et al*., 1992), body condition and/or nutritional status (Klaver *et al*., 1981; Noblet and Etienne, 1986) and nitrogen content of the feed (Volpelli *et al*., 1991; King *et al*., 1993b). However, a limited number of reports have studied the evolution of amino acids in sows' milk during lactation (Elliot *et al*., 1971; Duee and Joung, 1973; Davis *et al*., 1994).

The principal objective of this experiment was to examine the changes in dry matter, crude protein, gross energy and amino acid composition of sows' mature milk between days 5 and 26 *postpartum*.

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The milk production of ten Large White x Landrace multiparous sows in their fourth lactation was determined by weighing each of the nine piglets per litter before and after nursing, at 60 min intervals between 8:00 and 15:00 h (eight nursing periods) on days 4, 11, 18 and 25 of lactation. A high precision electronic balance (± 1 g) with an integration system was used. In order to avoid errors in the calculation of milk production owing to the possible excretion of faeces and urine during the feeding periods, the piglets were repeatedly prodded for a few minutes before suckling to incite defecation and/or urination. Milk production was estimated according to the recommendations of Speer and Cox (1984), employing values obtained by Noblet and Etienne (1986) to correct any weight loss of the piglets from metabolism and water evaporation.

On days 5, 12, 19, and 26 of lactation, piglets were separated from their dams for 90 min. The functional pectoral and inguinal glands were milked manually after injecting each sow with 20 i.u. oxytocin. Milk samples were kept at –20ºC until analysed. Dry matter were determined in duplicate by oven drying to constant weight at 87ºC and Kjeldahl-N (AOAC, 1995) were determined in duplicate and crude protein calculated as N X 6.38. Amino acid analysis (except tryptophan, proline and cystine) were carried out by ophthaldialdehyde precolumn derivatization following hydrolysis in 6 M-HCl, with amino acid separation on a HPLC system (Kontron Instrument, CH-Zurich, Switzerland) following the method described by Jones *et al*. (1981). Gross energy was determined using an adiabatic oxygen bomb calorimeter (IKA Calorimeter C4000-Janke & Kunkel, D-70129 Staufen, Germany). The sows were weighed the next day after farrowing and immediately after weaning.

Sows were moved to the farrowing compartment 5 d before parturition. The temperature was set at 16-22ºC and 400 W electric heaters were used in the piglet areas. Farrowing pens had partially slatted concrete floors. Sows were daily fed with a ration of 5.5 kg of a feed containing 13.2 MJ of metabolizable energy kg^{-1}, 172 g of protein kg^{-1} and 9.6g of lysine kg^{-1}, from day 4 of lactation.

The results were subjected to analysis of variance by applying the General Linear Model procedure of SAS (1999). Lactation stage was the factor included in the statistics model. The means were separated using the Student-Newman-Keuls test with $P < 0.05$.

The sows average weight after farrowing and average weight loss during lactation were 211 ± 6.1 kg and 1.4 ± 0.6 kg respectively. The average daily milk yield of sows, between days 4 and 25 of lactation, was 6.5 ± 0.5 kg and the average daily gain of litter during lactation was 1685 ± 168g.

The changes in milk production and dry matter, crude protein and energy contents of sows' milk are shown in Table 1. A significant effect ($P < 0.05$) of lactation stage on milk yield was observed. Milk production increased significantly ($P < 0.05$) as lactation advanced. However, no significant difference in milk production was found between days 18 and 25 of lactation. The peak of lactation was observed at day 18 (7.56 kg). This result is in agreement with Daza *et al*. (1999) and Etienne *et al.* (2000).

Dry matter, crude protein and gross energy concentrations of milk did not vary significantly during lactation. This is in agreement with other studies in which no significant variations in dry matter and protein contents were observed as the lactation period advanced (Klobasa *et al*., 1987; Rodgers and Alston-Mills, 1990; Volpelli *et al*., 1991). The changes in milk protein concentration observed in our study were similar to those found by Schoenherr *et al.* (1989) in sows housed at a temperature of 20ºC and fed with a feed containing 171 g of crude protein kg^{-1}. The energy concentration of the milk has also been reported

Table 1. Effect of stage of lactation of sows on milk production (kg d^{-1}) and dry matter (g kg^{-1}), protein (g kg^{-1}) and energy (Mcal kg^{-1}) concentrations

Item	Stage of lactation (days)				
	4-5	11-12	18-19	25-26	Sem
Milk production[1]	4.91[a]	5.94[b]	7.56[c]	7.32[c]	0.38
Dry matter[2]	195.7	192.2	185.4	184.1	2.31
Crude protein[2]	60.5	56.9	56.2	55.9	1.76
Gross energy[2]	1.30	1.18	1.16	1.17	0.03

[1] Control days: 4, 11, 18 and 25. [2] Control days: 5, 12, 19 and 26. Within rows, means with different superscripts are significantly different $P < 0.05$. Sem: standard error of mean.

Table 2. Effect of stage of lactation of sows on amino acids composition of milk (g/100 g protein)

Amino acid	Stage of lactation (days)				
	5	12	19	26	Sem
Lysine	5.97[a]	6.41[b]	7.05[c]	6.81[c]	0.12
Methionine	1.50 (25)	1.80 (28)	1.83 (27)	1.79 (26)	0.02
Threonine	4.08 (68)	4.12 (64)	4.20 (59)	4.15 (61)	0.04
Leucine	6.89[a] (114)	7.51[b] (117)	8.10[c] (115)	7.86[c] (115)	0.15
Isoleucine	3.36[a] (56)	3.65[bc] (57)	3.50[ba] (50)	3.80[c] (56)	0.05
Histidine	2.81 (47)	2.71 (42)	2.91 (41)	2.95 (43)	0.04
Arginine	3.55[a] (59)	4.26[b] (66)	4.24[b] (60)	4.60[c] (67)	0.13
Valine	4.34[a] (73)	4.54[a] (71)	5.92[b] (84)	5.34[c] (78)	0.18
Phenylalanine	4.42[a] (74)	3.88[b] (60)	3.81[b] (54)	3.92[b] (57)	0.06
Tyrosine	3.72[ab] (62)	3.95[b] (61)	3.63[a] (51)	3.67[a] (54)	0.04
Glycine	2.61 (44)	2.71 (42)	2.80 (40)	2.79 (41)	0.02
Alanine	3.65[a] (61)	3.40[a] (53)	3.94[b] (56)	3.55[a] (52)	0.05
Serine	4.31[ab] (72)	4.21[a] (66)	4.51[b] (64)	4.43[ab] (65)	0.04
Aspartic acid	6.53[a] (109)	7.09[b] (111)	7.53[c] (107)	7.29[bc] (107)	0.12
Glutamic acid	15.80[a] (265)	17.35[b] (271)	18.78[c] (266)	18.87[c] (277)	0.26

( ) = (amino acid: lysine) × 100. Within rows, means with different superscripts are significantly different ($P < 0.05$). Sem: standard error mean.

to vary very little during lactation (Pomar *et al*., 1991), although Noblet and Etienne (1986) detected a slight reduction after the fifth day of lactation.

The average total content of the 15 considered amino acids of sow milk (78.9 g/100 g protein) was lower than those found by Elliot *et al.* (1971), Duée and Jung (1973) and Dourmad *et al.* (1991) (89.4, 92.1 and 90.6 g/100g protein, respectively), but was similar to that reported by King *et al.* (1993a) (83.8 g/100g protein) and higher than that observed by Davis *et al.* (1994) (35 g l^{-1} of milk including proline and cystine). In our experiment the lysine average content of sow milk was 6.56 g/100g protein. Higher values of lysine were found by Elliot *et al.* (1971), Duée and Jung (1973), Dourmad *et al.* (1991) and King *et al.* (1993a) (7.1, 7.59, 7.24 and 6.95 g/100 g milk protein, respectively). However, the concentration of the other amino acids studied, when expressed as a proportion of lysine content, were similar to those attained by the same authors.

The concentration of most of the amino acids studied varied significantly ($P < 0.05$) with the stage of lactation (Table 2). Methionine, threonine, histidine and glycine concentrations did not change significantly throughout lactation while that of lysine, leucine, valine and glutamic acid increased in controls carried out at 19 and 26 days after parturition. Phenylalanine concentration was significantly higher at the start lactation (control day 5) than in subsequent controls, and the rest of considered amino acids also varied their contents during lactation. However, Elliot *et al.* (1971) found similar contents of the amino acids at 7, 14, and 21 days of lactation, although this experiment does not offer statistical analysis.

Since most amino acids are derived from milk proteins, the change in milk amino acid pattern during the course of lactation can probably be ascribed to a change during the course of lactation in the relative distribution of milk proteins containing different amino acid pattern. The ratio of casein to whey proteins, particularly immunoglobulins and α-lactalbumin, increased as lactation advanced (Klobasa *et al*., 1987). These authors found a ratio of total protein to albumin and inmunoglobulins proteins of 4:1 and 6:1 on 5 and 28 days of lactation respectively. Whey proteins generally have lower concentrations of glutamic acid and methionine and are richer in glycine and threonine compared to the casein proteins. Moreover the caseins are viewed predominantly as a source of dietary essential amino acid (Darragh and Moughan, 1998). Some results found in our experiment (lysine, leucine, valine and glutamic acid concentration changes) could be explained by these considerations.

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