GESTATION LENGTH IN THE ASTURIANA DE LOS VALLES BEEF CATTLE BREED AND ITS RELATIONSHIP WITH BIRTH WEIGHT AND CALVING EASE*

DURACIÓN DE LA GESTACIÓN EN LA RAZA BOVINA ASTURIANA DE LOS VALLES Y SU RELACIÓN CON EL PESO AL NACIMIENTO Y DIFICULTAD DE PARTOS*

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ADDITIONAL KEYWORDS

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PALABRAS CLAVE ADICIONALES

Factores ambientales. Hipertrofia muscular. Tamaño del ternero. Tamaño de la vaca.

SUMMARY

The significance of major environmental factors affecting Gestation Length (GL) in the Asturiana de los Valles beef cattle breed and the influence of GL on birth weight and calving ease have been analysed. The degree of muscularity of the calf at birth significantly affects GL: culard calves lengthened GL by more than 1 day with regards to normal calves; however, the way in which the degree of muscularity of dams affects GL is not clear; normally muscled dams seem to show a slightly longer GL than that of dams expressing some degree of muscular hypertrophy. Birth weight and calving ease increase 0.180 kg and 0.013 points respectively per day of GL.

RESUMEN

Se ha analizado la influencia de diferentes efectos ambientales en la duración de la gestación (DG) en la raza bovina Asturiana de los Valles, así como la influencia de la DG sobre la dificultad de parto y el peso al nacimiento. El grado de expresión de la hipertrofia muscular del ternero afecta significativamente a la DG: los terneros culones al nacimiento alargan la DG en más de un día respecto de los terneros normales; sin embargo el grado de expresión de la hipertrofia muscular en la vaca no afecta a la DG de forma tan clara: las reproductoras normales parecen presentar gestaciones ligeramente más largas que las reproductoras que presentan algún grado de hipertrofia muscular. El peso al nacimiento y la dificultad de parto se incrementan en 180 g y 0,013 puntos por día de gestación respectivamente.

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INTRODUCTION

Breeders pay little attention to gestation length (GL) as a cattle trait.

Since the classic review from Andersen and Plum (1965), not many papers have been devoted to this trait. However, GL has recently been included in some sire selection indices (Amer *et al*., 1998) in beef cattle. Most papers report that GL shows from moderate to high heritability (Andersen and Plum, 1965; Goyache and Gutiérrez, 2001), and high genetic correlations with birth weight (Bourdon and Brinks, 1982) and dystocia (Nadarajah and Burnside, 1989). In this sense, GL has been proposed as a breeding goal to reduce birth weight without affecting pre-weaning growth traits (Bourdon and Brinks, 1982; Brinks *et al*., 1991).

Dam age and calf sex are considered as major factors affecting GL (Andersen and Plum, 1965). Some other factors like breed (Liboriussen, 1977), dam and calf size (Nadarajah *et al*., 1989) and calving season (Brakel *et al*., 1957) seem to have a significant effect on GL. In beef cattle, muscular hypertrophy is expected to affect GL but its effect has not been well determined and available papers on the subject are contradictory (Menissier, 1982a).

Recently, we analysed the environmental factors affecting birth weight and calving ease in Asturiana de los Valles cattle (Goyache *et al*., 2000). Our results suggested that GL might be a factor affecting the observed behaviour of phenotypically culard and normal dams for calving ease. Phenotypically double muscled dams calved more easily than phenotypycally normal dams when muscularity of calf was considered. The aim of this paper is to determine the importance of certain environmental factors influencing GL in the Asturiana de los Valles cattle, focusing on the expression of muscular hypertrophy in dams. Additionally, the influence of GL on birth weight and calving ease will also be analysed.

MATERIAL AND METHODS

The *Principado de Asturias* Regional Government, through the Asturiana de los Valles Breeders Association (ASEAVA), has implemented performance recording (the CORECA database) based on nuclei, grouping farms according to their proximity and their production system arising from small farm size. Most dams and sires included in the CORECA database are registered in the Asturiana de los Valles Herdbook. The CORECA database is lent to ASEAVA to estimate breeding values of their sires.

A representative sample of the CORECA database was analysed. Available data has been described in Goyache *et al.* (2000). Performance recording includes mating date, calving date, birth weight of calf and calving ease. Calving ease was recorded using BIF Guidelines with the following scores: 1 (no assistance), 2 (minor assistance), 3 (hard assistance), 4 (caesarean section) and 5 (abnormal presentation). Score 5 was not considered for current analysis. Degree of muscularity is phenotypically classified as culard, normal and intermediate and recorded on calf at birth and on dam at the beginning of the reproductive age. Animals classified as normal are expected to be genotypically normal animals and heterozygous animals with a poorer expression of culard characteristics. Animals classified as culard are expected to be all the phenotypically culard animals.

GL was calculated from the last natural service or artificial insemination recorded. Because of the non experimental origin of data, observations outside the range of ±3 standard deviations were deleted following Azzam and Nielsen (1987) and Nadarajah *et al.* (1989). Thus, analysed observations ranged between 271 and 304 days. Only single calving records including calf sex, calving number, class of muscularity of calf, class of muscularity of dam, birth weight and calving ease score were considered. Consequently, only 4,143 records from 2,253 different dams were analysed.

STATISTICAL ANALYSIS

Statistical analysis was carried out using SAS® Version 8.2 (SAS, 1999). Duncan's multiple-range test was performed on all main-effect means affecting CI. Sum of squares were estimated using Type III test of GLM Procedure of SAS following the methodology described in Goyache *et al*. (2000) to analyse birth weight and calving ease. The principal effects included in the fitted model were

$$(1)\ GL_{ijklmno} = NY_i + M_j + P_k + S_l + T_m + TD_n + e_{ijklmno}$$

where $GL_{ijklmno}$ is the observation of the dependent variable gestation length; NY_i the effect of management group according to year of calving; M_j the effect of month of calving; P_k the effect of number of calving of the cow in six levels (first calving, second calving, third calving, fourth calving, from five to nine calvings, and more than nine calvings); S_l the effect of sex of calf (male and female); T_m: effect of degree of muscularity of calf (culard, normal or intermediate); TD_n: effect of degree of muscularity of dam (culard, normal or intermediate); and $e_{ijklmno}$ the error associated to the observation considered as a random variable. Additionally, the full model fitted to analyse GL in Asturiana de los Valles breed included the double interaction between calving number and sex of calf, muscularity of dam and muscularity of calf; between sex of calf and muscularity of calf and muscularity of dam; and, finally, between muscularity of dam and muscularity of calf.

Piedrafita *et al.* (2000), to estimate variation in GL as breeding season advances in Bruna del Pirineus beef cattle breed, include in the model they fitted the effect of the cow as random effect besides the error. Our data were analysed before to estimate the heritability of GL as dam trait (Goyache and Gutiérrez, 2001). In this analysis we found that permanent environmental effect (equivalent to include the effect of the dam as random effect was low and non significant (χ^2= 0.01; s.e.= 0.02). Thus, the effect of the cow was not included in the model fitted for the present analysis.

Birth weight was subsequently included as a linear covariate in the model in order to ascertain the influence of birth weight of calf on GL.

Birth weight and calving ease, considered as a continuous normal variable, were later analysed using the model described above with the addition of GL as a linear covariate.

RESULTS AND DISCUSSION

Mean squares, f-values and significance of different sources of variation included in the model fitted to analyse GL are shown in **table I**. The model explains a small proportion of GL variability (R^2=0.094). This low R^2 might be explained by the existence of some important factors affecting GL such as dam's size (Foot *et al*., 1960; Nadarajah *et al*., 1989), which are not included in the model. In addition, GL is expected to show a high genetic determination (Azzam and Nielsen, 1987; Goyache and Gutiérrez, 2001). Management group, month of calving, calving number, sex of calf and muscularity of calf at birth were observed to have a significant influence on GL. Furthermore, double interactions between calving number and calf sex, and sex and muscularity of calf affect GL significantly. The influence of muscularity of dam was very close to significance (p= 0.0513). No significant interaction between muscularity of dam and muscularity of calf was found.

Least square means of GL for the major phenotypic effects affecting the trait are shown in **table II**. Values of raw means and least square means are substantially the same because of the small influence of each effect on GL. The GL mean in Asturiana de los Valles cattle was 287 ± 6.07 days. This GL is similar to others reported in beef cattle producing hard calves at birth: 289 days in Simmental cattle, 288 days in Charolais cattle or 285 days in Rubia Gallega cattle (Vallejo *et al*., 1989). GL shows significant phenotypic correlations (p<0.0001) with birth

Table I. *Degrees of freedom, mean squares, f-values and significance of sources of variation affecting gestation length in the Asturiana de los Valles breed.* (Grados de libertad, cuadrados medios, valores de F y significación de las fuentes de variación que afectan a la duración de la gestación en la raza Asturiana de los Valles).

Sources of variation	d.f.	Mean square	F-value	p
Management group	65	99.73	2.93	0.0001
Month of calving	11	157.22	4.61	0.0001
Calving number	5	308.64	9.05	0.0001
Sex of calf	1	964.78	28.3	0.0001
Muscularity of calf	2	754.86	22.14	0.0001
Muscularity of dam	2	101.34	2.97	0.0513
Calving number x sex of calf	5	77.53	2.27	0.0447
Calving number x muscularity of dam	10	52.27	1.53	0.1208
Calving number x muscularity of calf	10	27.91	0.82	0.6104
Muscularity of calf x sex of calf	2	116.73	3.42	0.0327
Sex of calf x muscularity of dam	2	92.27	2.71	0.0669
Muscularity of calf x muscularity of dam	4	39.84	1.17	0.3225
error	4023	34.09		

Table II. *Least square means and standard errors (s.e.) of gestation length in the Asturiana de los Valles breed for major sources of variation.* (Mínimos cuadrados medios y errores estándar (se) de la longitud de la gestación en la raza Asturiana de los Valles).

	Number	Least square mean	s.e.
Full database	4143	287.1[a]	
Sex of calf			
Female	2102	286.6[b]	0.291
Male	2041	287.5[a]	0.310
Calving number			
First	599	285.7[d]	0.340
Second	609	286.2[bc]	0.371
Third	578	286.7[c]	0.371
Fourth	531	287.1[b]	0.386
From 5 to 9	1626	287.0[ab]	0.288
More than 9	200	289.3[a]	1.104
Muscularity of calf			
Culard	1443	287.9[a]	0.295
Intermediate	809	287.0[b]	0.369
Normal	1891	286.2[c]	0.391
Muscularity of dam			
Culard	487	287.0[a]	0.295
Intermediate	448	286.8[a]	0.528
Normal	3208	287.1[a]	0.174

Means with different superscripts differ significantly for p<0.05.

weight (r= 0.21) and calving ease (r= 0.08). These latter traits show a phenotypic correlation between themselves of r= 0.34. Correlation between GL and birth weight is within the admitted range of 0.15-0.52 (Andersen and Plum, 1965). Bellows *et al.* (1971) found higher correlation values (0.25) between GL and calving ease in Hereford cattle, and similar but non-significant values (0.10) in Angus cattle. Burfening *et al.* (1978) found a significant correlation between GL and calving ease of 0.04.

The GL mean with respect to calving month is always between 287 and 288 days from October to May, except in January. In the remaining months, GL is below 287 days, with the minimum in August (285 days). These results are in agreement with some others from the literature that report the lengthening of GL during the winter months (Brake *et al.*, 1952; Andersen and Plum, 1965).

An increase in calving number prolongs GL. Heifers show a GL 0.5 days shorter than second calving dams and 1.0 days shorter than adult dams **(table II)**. In this analysis, heifers' GL is 1.4 days shorter than the GL general mean, as is generally accepted in the literature (Andersen and Plum, 1965). Older Asturiana de los Valles dams delay calving by 2.2 days relative to the general GL mean, as was found by Brinks *et al.* (1991) in Angus cattle. The influence of calving number on GL seems to be linked to sex of calf (Jaffar *et al.*, 1950) **(table III)**. First calving seems to be more important than sex of calf for GL determination. In this paper, heifers' GL means are not significantly different for sex of calf. On the other hand, second and third calving dams show greater differences in GL depending on calf sex. The GL mean ranges from 285.5 to 285.8 days for female offspring of these dams, which is comparable with heifers' means under the same circumstances. However, the GL mean reaches above 287 days in the case of male offspring of second and third calving dams, this value being closer to adult dams' GL means in the same conditions.

Table III. *Least square means and standard errors (s.e.) of gestation length in the Asturiana de los Valles breed for calving number and sex of calf.* (Mínimos cuadrados medios y errores estándar (se) de la longitud de la gestación en la raza Asturiana de los Valles para el numero del parto y sexo del ternero).

	Number	Least square mean	s.e.
First calving			
Female calves	314	285.8^{d}	0.417
Male calves	285	285.7^{d}	0.435
Second calving			
Female calves	307	285.5^{cd}	0.454
Male calves	302	287.1^{b}	0.452
Third calving			
Female calves	299	285.8^{bc}	0.439
Male calves	279	287.7^{ab}	0.471
Fourth calving			
Female calves	290	287.0^{bc}	0.463
Male calves	241	287.3^{ab}	0.487
Form 5 to 9 calving			
Female calves	801	286.6^{bc}	0.337
Male calves	825	287.5^{ab}	0.353
More than 9 calving			
Female calves	91	288.8^{b}	1.167
Male calves	109	289.8^{a}	1.211

Means with different superscripts differ significantly for $p<0{\cdot}05$.

As was expected from the literature, sex of calf, muscularity of calf and their interaction significantly influenced GL. Asturiana de los Valles male calves lengthen GL by 1.0 days compared to female calves **(table II)**. Nadarajah *et al*. (1989) found slightly lower values in Canadian Holstein cattle. The presence of muscular hypertrophy in the calf delays parturition (Raimondi, 1963). In Asturiana de los Valles cattle, culard calves at birth show a GL of 1.7 and 0.9 days longer than normal and intermediate calves at birth **(table II)**. The expression of muscular hypertrophy is more pronounced in males (Menissier, 1982b). In the present analysis, we found significant differences of GL for muscularity category of calf within each sex of calf, but differences are higher in males: 2.2 days between culard and normal male calves and 1.1 between culard and normal female calves **(table IV)**.

When birth weight is included in the fitted model as a linear covariant, the explained variance increases by 2.2 p.100 (R^2=0.116). An increase in the birth weight is significantly associated to a longer GL (0.14 days/kg). The

Table IV. *Least square means and standard errors (s.e.) of gestation length in the Asturiana de los Valles breed for muscularity and sex of calf.* (Mínimos cuadrados medios y errores estándar (se) de la longitud de la gestación en la raza Asturiana de los Valles para la musculación y sexo del ternero).

	Number	Least square mean	s.e.
Culard calves			
Female calves	687	287.1^{bc}	0.347
Male calves	756	288.6^{a}	0.346
Intermediate calves			
Female calves	413	286.5^{cd}	0.422
Male calves	396	287.4^{b}	0.459
Normal calves			
Female calves	1002	286.0^{d}	0.427
Male calves	889	286.4^{cd}	0.454

Means with different superscripts differ significantly for $p<0{\cdot}05$.

covariate value obtained in this analysis is very similar to that found in Angus cattle by Brinks *et al*. (1991). The reported standard deviation of birth weight in Asturiana de los Valles cattle is ±6.7 kg (Goyache *et al*., 2000). Within this range, GL could vary by one day. The influence of GL could partially explain the birth weight differences for sex and muscularity of calf observed previously by Goyache *et al*. (2000).

However, the influence of birth weight on GL seems to be stronger than that expressed by the covariate value. When GL is adjusted for the influence of birth weight its phenotypic correlations with birth weight and calving ease are higher and still significant (0.367 and 0.135 respectively). Also, when birth weight is included in the model, the effect of muscularity of dam on GL becomes significant. The actual influence of this effect on GL probably corresponds to homozygous culard dams. There are some difficulties in classifying cularity phenotypically in adult animals, especially in females (Menissier, 1982b). In the analysed database, there are probably a few homozygous culard dams classified as intermediate. The fitted model was re-started twice, comparing the phenotypical presence of cularity *versus* the phenotypical absence of cularity and probable culard homozygosis *versus* non-homozygosis. Both variables were seen to have a significant influence on GL. Phenotypically normal dams delay parturition by 0.24 days with regards to dams showing some phenotypical degree of muscularity. Phenotypically culard dams shortened GL by 0.13 days in comparison with the other dams. Therefore, normal dams seem to delay parturition by 0.11 days relative to intermediate dams. Similar results can be found in the literature. Michaux and Hanset (1986) found GLs 0.2-0.5 shorter in culard heifers than in those classified as *mixtes* in Blanc-Bleu Belge cattle. Culard dams present a smaller size than normal dams (Menissier, 1982a) within genetically comparable management groups. This might offer an explanation for the delay of parturition in normal dams, since GL increases with dams' size (Andersen and Plum, 1965; Nadarajah *et al*., 1989).

GL, as a linear covariant, significantly affects both birth weight and calving ease in Asturiana de los Valles cattle. Despite what has been reported in the literature (Burfening *et al*., 1978), further analysis did not show any non-linear influence of GL (included in the model as a quadratic or cubic covariate) either on birth weight or calving ease in the analysed database. Birth weight and calving ease increase 0.180 kg and 0.013 points respectively per day of GL. The GL influence on calving ease remains when birth weight is included in the model, but the covariate value drops to 0.006 points of the calving ease score per day of GL. These values are in agreement with others found in the literature. Brinks *et al.* (1991) report that birth weigh increase 0.154 kg by GL day in Angus cattle. Bellows *et al*. (1971) reported a non-significant increase of calving ease in Hereford cattle of 0.04.

IMPLICATIONS

GL is a reproductive trait that is significantly related to birth weight and calving ease. This paper has contributed to clarify the phenotypical relationships of GL with birth weight and calving ease in Asturiana de los Valles beef cattle breed. The influence of GL on calving ease seems to be smaller than for birth weight. We can not explain the observed differences in calving ease performance of double muscled dams (Goyache *et al.*, 2000) according with the influence of GL. The influence of the degree of muscularity of the dam on GL remains unascertained. However muscled dams tend to shorten GL with respect to normal dams. On the other hand, despite heritabilities for GL, birth weigh and calving ease have been estimated in our breed (Gutiérrez *et al.*, 1997; Goyache and Gutiérrez, 2001) the genetic relationships between them remain unascertained. It could be an interesting focus for future works. Further research will be needed to clarify these topics and to allow the use of GL information in a beef cattle improvement program to reduce dystocia without affecting growth traits as it has been suggested before (Bourdon and Brinks, 1982; Brinks *et al.*, 1991).

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