EFFECT OF CROSS BREEDING WITH HISPANO-BRETÓN AND BURGUETE ON PRODUCTIVE PARAMETER AND DYNAMICS OF GROWTH OF "GALICIAN MOUNTAIN" FOALS

José M. Lorenzo[1]*, Daniel Franco[1], Santiago Crecente[2], María Victoria Sarriés[3] and

José Antonio Vázquez[4]

[1]Centro Tecnológico de la Carne de Galicia, Rúa Galicia Nº 4, Parque Tecnológico de Galicia, San Cibrán das Viñas, 32900 Ourense, Spain
[2]INGACAL Instituto Gallego de la Calidad Agroalimentaria. Centro de Investigaciones Agrarias de Mabegondo Apartado 10. 15080 La Coruña, Spain
[3]Departamento de Producción Agraria, Escuela Técnica Superior de Ingenieros Agrónomos, Universidad Pública de Navarra, Campus de Arrosadía, 31006, Pamplona, Spain
[4]Grupo de Reciclado y Valorización de Residuos (REVAL). Instituto de Investigaciones Marinas (IIM-CSIC), Eduardo Cabello, 6, 36208, Vigo, Spain
*jmlorenzo@ceteca.net

Abstract – The "Galician Mountain" (GM) horse is an autochthonous crossbred from the North of Spain adapted to an extensive production system. The objective was to study the effect of cross breeding with Hispano-Bretón (HB) and Burguete (B) on productive parameter and dynamics of growth of "Galician Mountain" foals. For this study, thirty-nine foals, twelve from crossing GM×HB and twenty-seven from crossing GM×B were used. Moderate biphasic profiles were observed from 120 days. The partial plateau phases and the total maximum growth or final asymptotes were experimentally well defined. The predictive ability of proposed equations to model the experimental data was high with a goodness of fit higher than 0.987. The sex of foals did not affect the growths and the differences among crossbreeds were not significant (*P*>0.05).

I. INTRODUCTION

Horsemeat is characterized by low fat, low cholesterol content and rich in iron [1]. This meat has a favorable dietetic fatty acid profile, with a high content of unsaturated fatty acids in relative to saturated acids and contains a greater proportion of components from the α-linolenic fatty acid family [2, 3]. These nutritional characteristics reveal that this type of meat may be considered as a new alternative in meat consumption.

The "Galician Mountain" horse is an autochthonous crossbred located in the mountains of Galicia (NW Spain), where it is born and raised. At the end of the 19th century and the beginning of the 20th century, horses of heavy breeds, such as Hispano-Breton and Burguete, were introduced into Spain to increase the corpulence of Spanish horses.

On the other hand, the success of animal production is mainly dependent on the minimization of the relationship between growths and nutrient costs. The correct description of growth data is especially important when a rigorous and predictive quantification is necessary in order to establish that animals are ready for market [4]. The most robust tool to address organism live-weight is obtained by the use of sigmoidal equations that permit to evaluate all the characteristic phases of animal growth [5].

The aim of this study was to assess the effect of cross breeding with Hispano-Bretón (HB) and Burguete (B) on productive parameter and dynamics of growth of "Galician Mountain" (GM) foals.

II. MATERIALS AND METHODS

II.1. Experimental design and animal management

For this study, thirty-nine foals, twelve from crossing GM×HB and twenty-seven from crossing GM×B were used. Animals were obtained from the experimental herd of Agricultural Research Centre of Mabegondo (Marco da Curra, A Coruña, Spain). Animals were reared with their mothers on pasture and were allowed to suck freely. Foals were weaned when they were 6-8 months old. Then, foals were fed with concentrate and pasture. Live weight of foals was recorded monthly during the experimental period.

II.2. Foals growth and mathematical modelling

The biphasic sigmoid trends obtained for the foals' growth were fitted to the sum of two logistic equations [6, 7]:

$$G = \frac{G_{m1}}{1+\exp\left[\mu_{m1}(\tau_1 - t)\right]} + \frac{G_{m2}}{1+\exp\left[\mu_{m2}(\tau_2 - t)\right]}$$

Another reparameterised format of this equation was also used to characterise all the phases of growth and obtain other parameters of biological interest [5]:

$$G = \frac{G_{m1}}{1+\exp\left[2+\frac{4v_{m1}}{G_{m1}}(\lambda_1 - t)\right]} + \frac{G_{m2}}{1+\exp\left[2+\frac{4v_{m2}}{G_{m2}}(\lambda_2 - t)\right]}$$

where, G_{m1} and G_{m2} are the maximum growths in the first and second sigmoid of the biphasic pattern (kg), respectively; μ_{m1} and μ_{m2} are the specific maximum rates of growth in the first and second sigmoid of the biphasic pattern (weeks^{-1}); τ_1 and τ_2 are the times required to achieve the half of the maximum growth in the first and second sigmoid of the biphasic pattern (weeks); v_{m1} and v_{m2} are the maximum rates of growth in the first and second sigmoid of the biphasic pattern (kg weeks^{-1}); λ_1 and λ_2 are the lag phases for the first and second sigmoid (weeks). In addition, $G_{mf} = G_{m1} + G_{m2}$ is the final maximum growth (kg) in the biphasic process (value of G when $t \rightarrow \infty$). In all cases, net growths of foals were normalized by subtracting the corresponding initial weights to all experimental data.

2.3. Numerical methods and statistical analysis

Growth of foals were modelled by minimisation of the sum of quadratic differences between observed and predicted values, using the non linear least-squares (quasi-Newton) method provided by the macro '*Solver*' of the Microsoft Excel spreadsheet. Confidence intervals from the parametric estimates (Student's *t* test) and consistence of mathematical models (Fisher's *F* test) and residual analysis (Durbin-Watson test) were evaluated by "*SolverAid*" macro (Levie's Excellaneous website:http://www.bowdoin.edu/~rdelevie/excellaneous).

III. RESULTS AND DISCUSSION

The results of the foal's growth from Burguete and Hispano-Bretón breeds are shown in Figure 1. The profiles fitted to the experimental data according to the model first equation or second equation is also displayed. Table 1 lists the values of the kinetic parameters and the statistical analyses performed on the numerical fittings. Moderate biphasic profiles were observed from 120 days. Nevertheless, these patterns were not so clear than previously reported for "Galician Mountain" and GM×HB crossing breeds [7]. The partial plateau phases and the total maximum growth or final asymptotes were experimentally well defined

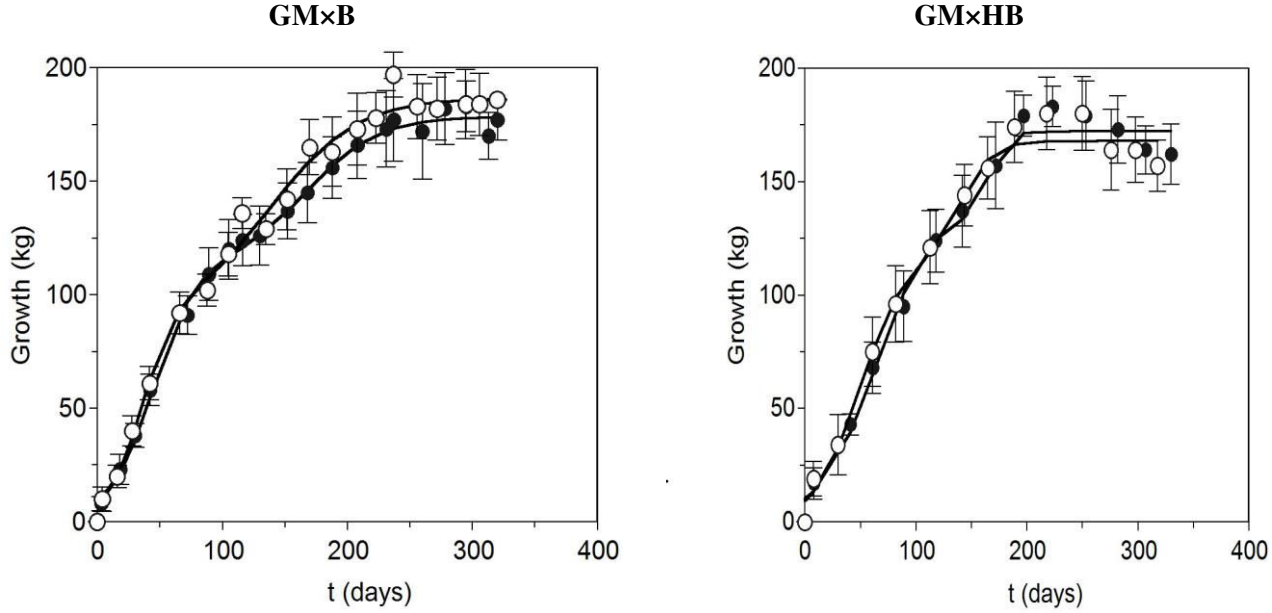

Figure 1. Growth of female (●) and male foals (○) from crossing GM×HB and from crossing GM×B

and, hence, the values of G_{m1}, G_{m2} and G_{mf} were statistically (P<0.05) significant (Table 1). The predictive ability of equation one or two to model the experimental data was high with a goodness of fit of not less than 0.987. All the parameters for GM×B growths were statistically (P<0.05) significant, and autocorrelation was not observed in the residuals (data not shown). However, in the case of GM×HB nearly half of the coefficients were not significant. The sex of foals did not affect the growths and the differences among crossbreeds were not significant (P>0.05). The mentioned growths (G_{mf} values) were lower than those obtained by GM and GM×HB breeds finishing with two amounts of feeding [7].

Table 1. Parametric estimations and confidence intervals (α = 0.05) corresponding to the first and second equation applied to predict the growth of foals.

	GM×B female	**GM×B male**	**GM×HB female**	**GM×HB male**
G_{m1}	114.07±25.26	129.43±18.03	140.16±27.07	119.49±57.20
v_{m1}	1.35±0.34	1.25±0.22	1.37±0.48	1.46±0.56
λ_1	13.65.±10.56	22.93±9.70	13.74 (NS)	9.49 (NS)
μ_{m1}	0.047±0.018	0.039±0.010	0.039±0.018	0.049±0.031
τ_1	55.90±12.36	74.78±10.99	65.03±16.74	50.50±26.79
G_{m2}	59.68±28.18	46.06±20.05	32.03±28.26	48.37 (NS)
v_{m2}	0.68±0.39	0.90±0.72	4.05 (NS)	0.90 (NS)
λ_2	133.58±55.67	179.92±38.68	167.25 (NS)	116.45±89.85
μ_{m2}	0.046±0.039	0.078±0.074	0.047 (NS)	0.075 (NS)
τ_2	177.42±24.71	205.55±16.88	171.15 (NS)	143.28±39.27
G_{mf}	173.75±6.79	175.49±5.99	172.18±7.25	167.86±7.02
R^2	0.993	0.994	0.987	0.987
P-value	<0.001	<0.001	<0.001	<0.001

NS: non-significant; R^2: coefficient of multiple determination; p-value from Fisher's F test (α = 0.05)

IV. CONCLUSION

The proposed equations demonstrated to be adequate to model and predict the bi-sigmoid trends of foal growths. Kinetic parameters obtained from them are a valuable tool for characterizing growth phases and assessment differences among sex, feed or growth conditions. However, in the present study sex did not show significant differences on growth parameters in both crossbreeds.

ACKNOWLEDGEMENTS

Authors are grateful to INIA (Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria) for the financial support (Project RTA2012-00090-C03).

REFERENCES

1. Lorenzo, J. M., Sarriés, M. V., Tateo, A., Polidori, P., Franco, D., & Lanza, M. (2014). Carcass characteristics, meat quality and nutritional value of horsemeat: A review. Meat Science 96:1478-1488.
2. Lorenzo, J. M. (2013). Horsemeat as a source of valuable fatty acids. European Journal of Lipid Science and Technology 115:473-474.
3. Lorenzo, J.M., Fuciños, C., Purriños, L. & Franco, D. (2010). Intramuscular fatty acid composition of "Galician Mountain" foals breed. Effect of sex, slaughter age and livestock production system. Meat Science 86:825-831.
4. Kebreab, E., Schulin-Zeuthen, M., Lopez, S., Soler, J., Dias, R.S., de Lange, C.F.M., & France, J. (2007). Comparative evaluation of mathematical functions to describe growth and efficiency of phosphorus utilization in growing pigs. Journal of Animal Science 85:2498-2507.
5. Vázquez, J. A., Lorenzo, J. M., Fuciños, P., & Franco, D. (2012). Evaluation of non-linear equations to model different animal growths with mono and bi-sigmoid profiles. Journal of Theoretical Biology 314:95-105.
6. Franco, D., Rois, D., Vázquez, J. A., Purriños, L., Gonzalez, R., & Lorenzo, J. M. (2012). Breed

effect between Mos rooster (Galician indigenous breed) and Sasso T-44 line and finishing feed effect of commercial fodder or corn. Poultry Science 91:487-498.

7. Franco, D., Crecente, S., Vázquez, J. A., Gómez, M., & Lorenzo, J. M. (2013). Effect of cross breeding and amount of finishing diet on growth parameters, carcass and meat composition of foals slaughtered at 15 months. Meat Science 93:547-556.