INBREEDING SITUATION IN A RETINTO BEEF CATTLE POPULATION

SITUACION DE LA CONSANGUINIDAD EN UNA POBLACION DE VACUNO DE CARNE DE RAZA RETINTA

Serrano, I.[1], M. Mayer[2], A. Rodero[1] and A. Molina[1]

[1]Departamento de Genética. Facultad de Veterinaria. Universidad de Córdoba. 14005 Córdoba. España.
[2]Institut für Tierzucht und V.B. Tierärtztliche Hochschule. Hannover. Deutchsland.

Additional keywords

Pedigree cattle analysis. Breed structure. Herdbook analyses. Beef cattle. Inbreeding coefficient. Retinto beef cattle.

Palabras clave adicionales

Análisis del *pedigree* en vacuno. Estructura poblacional. Análisis del libro genealógico. Vacuno de carne. Coeficiente de consanguinidad. Vacuno retinto.

SUMMARY

In a sample of Retinto Beef Cattle under control of a breeding program in Andalusia, the average current inbreeding coefficient has been estimated. Ancestral information on 492 dams and 25 sires was analysed. The average current inbreeding coefficient (F) calculated for the whole sample was 1.52 p.100 but the pedigree information was very incomplete. Taking into consideration only the females with information equal or greater than 25 p.100 in the third ancestral generation, the current inbreeding coefficient (F) ranged from 2.06 p.100 to 3.32 p.100 with information percentage at 100 p.100.

The estimated F value in these animals compared with those values obtained in other beef breeds is the highest at the present time, only being comparable to those reported by Kidd *et al.* (1980) for the Iberian Mertolenga and de Lidia breed. This work confirmed Kidd's hypothesis (1980) concerning the great F value calculated in this breed. This is explained by breeding practices and inbreeding from mating closely related animals (12.2 p.100 females showed a value of F>0 and 3.9 p.100 showed F=25 p.100).

Futher work must be done in this field to estimate the current inbreeding coefficient of the breed which appears extremely high and to establish a mating policy.

RESUMEN

Se ha estimado la media del coeficiente actual de consanguinidad en una muestra de ganado vacuno de carne de raza Retinta. Esta muestra consiste en los animales bajo control del plan de mejora llevado a cabo en poblaciones andaluzas. Se han analizado genealogías de 492 vacas madres y 25 sementales. La media calculada del coeficiente actual de consanguinidad (F) para la muestra es F=1,52 p.100, pero hay que tener en cuenta que la información genealógica era muy incompleta. Considerando sólo las hembras que cuentan con una información en la tercera generación igual o mayor al 25 p.100, el valor de F tiene un rango entre 2,06 y 3,32 p.100 cuando el porcentaje de información es del 100 p.100.

El valor estimado de la F es muy elevado si lo comparamos con los obtenidos para otras razas de carne, siendo comparable sólo con los valores calculados por Kidd *et al.* (1980) para las razas ibéricas

Mertolenga, Toro de Lidia y Retinto. Este trabajo confirma las hipótesis de Kidd *et al.* (1980) sobre el alto valor de F estimados por ellos en el ganado Retinto. Este elevado valor podría explicarse por la costumbre de los criadores de utilizar un reducido número de sementales de la propia ganadería y al cruzamiento de individuos estrechamente emparentados (12,2 p.100 de las vacas madres analizadas presentaban un valor de F>0 y el 3,2 p.100 de F=25 p.100).

Esos resultados señalan la necesidad de ampliar estos estudios a un mayor número de individuos de la raza para estimar el coeficiente de consanguinidad que parece ser extremadamente alto, así como establecer una política de cruzamientos adecuada.

INTRODUCTION

The herd book of the Retinto breed was begun in the year 1976 with 18346 animals from 390 herds. As of today there are 13041 dams and 377 sires registered from 262 herds.

The aim of this study is to estimate the present inbreeding situation in the Retinto population. Very few researches have been reported regarding inbreeding situation in beef cattle breeds. Previous work by Kidd *et al.* (1980) indicated an average inbreeding coefficient of F=8 p.100 by comparison with the observed and expected heterozygosity at 7 codominant system tested. In this paper we study one sample of the Andalusian population.

These animals were under control of a breeding program in Andalusia. This program joins 9 herds with a total of 680 cows and 54 bulls. Ancestral information of the animals was provided by the Breeders Association on 492 females and 25 bulls.

The objectives were the following: to know the available pedigree information; to calculate the inbreeding coefficient for a better estimation of genetic parameters and to estimate the inbreeding coefficient for the population and for every animal in order to establish a mating policy.

MATERIAL AND METHODS

Were analyzed 458 cows and 89 bulls registered in the herd book.

From the information provided by the Breeders Association, a DataBase IV data bank was established, recording every animal along with its parents. A Fortran program was used to recode all the animals with numbers in such a way that the ancestry should have a smaller number than the progeny and also to check the data integrity.

To calculate the inbreeding coefficient (F) and the relationships among the animals, we used a Fortran code based on a recursive method suggested by Quaas (1976). All pedigree information available was used.

RESULTS

In this study we were able to know how the bulls had been distributed in the herds over the years and the culling policy followed for the males.

The bulls were always used in their own herds with only two exceptions: one bull in 1985 and another in 1986 having respectively 4 and 2 son in another herd.

In one year, every herd registered progenies of one or two bulls in the herd book. Exceptionally, we found in 1984, a herd reporting calves from four bulls and another one in 1985 and 1986 from

Table I. Inbreeding coefficient (F) and the percentage of ancestors known in every generation. (Coeficiente de consanguinidad (F) y porcentaje de antepasados conocidos en cada generación).

	N	N (F>0)	F (p.100)	G1	G2	G3	G4	G5
Total	517	62	1.52	92.4	81.8	42.3	6.0	0.2
Females	492	60	1.57	92.2	81.4	42.8	6.0	0.2
Males	25	2	0.43	96.0	91.0	40.0	5.0	0.7

N= Frequency.
G*n*= Ancestral generation considered.

3 and 4 bulls, respectively.

The bulls normally only presented registered progeny during two mating seasons, with the exception of four bulls: *Caprichoso*, used from 1979 to 1982, *Chato*, 1979-1983, *Bandido*, 1982-1985, and *Tomatero*, 1984-1987.

The calculated average inbreeding coefficient (F) for the whole sample was 1.52 p.100. It was 0.43 p.100 for males although positive in only two **(tables I and II)**.

The pedigree information was very incomplete. For females the information we had for the fifth generation was 0.2 p.100 which means that of the 32 ancestors only 0.06 were known. For the fourth generation it was 6 p.100 and for the third it was 42.8 p.100 **(table I)**. For them, F has a mean of 1.57 p.100.

The frequency distribution of inbreeding coefficient for the female individuals is shown in **table III**. For 60 females (12.2 p.100 of those studied) the F was higher than 0. We should point out the high value of F=25 p.100 for 3.9 p.100 of those sampled.

Table II. Inbreeding coefficient (F) and percentage of known ancestors for the males with F>0. (Coeficiente de consanguinidad (F) y porcentaje de antepasados conocidos en cada generación para los machos con F>0).

F (p.100)	G1	G2	G3	G4	G5
6.25	100	100	25.0	0.0	0.0
4.69	100	100	75.0	12.5	0.0

G*n*= Ancestral generation considered.

Table III. Frequency and percent of the inbreeding coefficient for the females in the breeding program. (Frecuencia y porcentaje de consanguinidad para las hembras del programa de mejora).

F (p.100)	frequency	percent
0.00	432	87.8
1.10	1	0.2
1.56	4	0.8
3.13	9	1.8
4.68	1	0.2
5.47	1	0.2
6.25	12	2.4
12.50	10	2.0
15.63	2	0.4
23.44	1	0.2
25.00	19	3.9

Table IV. *Inbreeding coefficient and percentage of known ancestors for different female groups with third generation information.* (Coeficiente de consanguinidad y porcentaje de antepasados conocidos para diferentes grupos de hembras con información en la tercera generación).

	N	N (F>0)	F p.100	G1	G2	G3	G4	G5
Females	492	60	1.57	92.2	81.4	42.4	6.0	0.2
G3>=25	363	59	2.06	99.3	95.6	57.5	8.2	0.3
G3>=50	261	49	2.13	99.6	98.2	70.3	10.7	0.4
G3>=75	146	38	2.65	100	99.8	86.3	15.8	0.7
G3 =100	65	23	3.32	100	100	100	21.7	0.1

Considering only the females with information equal or greater than 0.25 p.100 in the third generation, the inbreeding coefficient ranged between 2.06 p.100 and 3.32 p.100 when the information percentage was respectively 25 and 100 p.100 **(table IV)**.

When we consider the different F values for the female birth year groups, we observe higher values after 1981 because of the higher level of ancestral information. The years 1982-1987 have an average F of 2.35 p.100 and earlier than that we have a lack of information **(table V)**.

DISCUSSION

Because of the incomplete pedigree information we were only able to study current inbreeding. Normally close

Table V. *Inbreeding coefficient (F) and the percentage of known ancestor in every generation for different female year-groups.* (Coeficiente de consanguinidad y porcentaje de antepasados conocidos en cada generación para los diferentes grupos de años de las hembras).

YEAR	N	N (F>0)	F (p.100)	G1	G2	G3	G4	G5
1987	36	10	1.26	88.9	86.8	71.5	21.2	1.7
1986	67	10	1.98	88.8	86.6	53.2	6.7	0.2
1985	67	14	3.57	95.5	94.4	59.0	6.9	0.1
1984	96	15	1.71	98.4	96.1	55.9	9.8	0.4
1983	45	6	2.50	93.3	85.0	44.4	6.4	0.1
1982	17	3	4.41	94.1	76.5	44.1	2.2	0.0
1981	31	1	0.10	77.4	69.4	25.0	0.8	0.0
1980	38	1	0.08	98.7	80.9	25.0	0.0	0.0
1979	34	0	0.00	79.4	62.5	18.4	0.7	0.0
1978	25	0	0.00	96.0	74.0	10.0	0.0	0.0
1977	13	0	0.00	96.2	61.5	0.0	0.0	0.0
1976	10	0	0.00	80.0	15.0	2.5	0.0	0.0
1975	3	0	0.00	100	50.0	8.3	0.0	0.0

inbreeding is avoided and the rate of current inbreeding is less than non-current inbreeding (Bollmeier, 1990; Schmidt, 1990).

We conclude that despite the lack of ancestral information, we obtained a very high coefficient for the females sampled, F= 1.57 p.100. 12 p.100 of the studied females had a F>0. The mean inbreeding coefficient for the inbred cows was 12.8 p.100. 3.9 p.100 of all females had F=25 p.100 which may indicate that they came from parent-offspring mating.

The average inbreeding estimated by Kidd *et al.* (1980) of F=8 p.100 was greater than that expected from mating of first cousins. They used one estimation method based on the difference between the observed and the expected heterozygosity and the F value can have two different explanations. It can reflect present inbreeding of individual animals sampled and it can also be due to the Whalund effect which occurs with subdivision of a population. That is the case of this breed where artificial insemination is just being undertaken and breeders still tend to rely on their own or neighbouring bulls.

Looking at the inbreeding coefficient literature we find quite extensive information on dairy populations but very little on beef cattle. In all these papers the current inbreeding coefficient is reported over more than five generations **(table VI)**.

To compare our results with others obtained from different beef breeds, we should refer to the papers with four or five ancestral generations considered. Watson (1963) calculated an inbreeding coefficient in the Welsh Black population ranging between 2.3-2.8 p.100 for males and between 0.8 - 1.2 p.100 for females. Machbert (1981) investigated the German Gelbvieh cattle and estimated an inbreeding coefficient of F=0.6 p.100. A higher value was obtained for this breed in France where Reichenbach (1983) reported a value of F=1 p.100.

Kidd *et al.* (1980) reported an average inbreeding coefficient for the Spanish Lidia cattle of F=17 p.100 and for the Portuguese Mertolenga breed a coefficient of F=5 p.100, using the above mentioned method.

In dairy cattle, we found some references on current inbreeding coefficients. Diers and Langenberg (1988) a mean F=0.4 p.100 in Red Cattle from Westfalia. This same dual purpose breed was used by Schmidt (1990) who investigated three random samples of female calves and tested bulls born in the years 1974, 1980 and 1984 with nearly three complete generation pedigrees. He obtained the following values for the above years: F=0.12 p.100, F=0.20 p.100 and F=0.38 p.100.

Bollmeier *et al.* (1990) calculated a mean inbreeding coefficient ranging between 0.17 p.100 and 0.39 p.100 in Wertenberg Brown cattle for three samples of calves born in the years 1971-2, 1976-7 and 1986-7 respectively, whose ancestry were traced back over three generations.

It might also be interesting to comment on some noncurrent inbreeding coefficients estimated for dairy or dual purpose breeds. Some of them are topic papers because of the great number of animals considered and others be used to compare noncurrent with current coefficients.

Hudson and VanVleck (1984) estimated the inbreeding coefficient for several dairy cattle populations in the

USA. The values reported ranged from 0.3 p.100 in the Holstein-Frisian to 2.9 p.100 in the Ayrshire **(table VI)**.

Non current inbreeding coefficients were reported for the dual purpose Brown breed from Wurttenberg by Bollmeier *et al.* (1990). When they traced back five ancestral generations the coefficient was between 0.56 and 0.92 p.100.

If we take into account the first studies

Table VI. *Inbreeding coefficient estimated for different cattle population.* (Coeficiente de consanguinidad estimado para diferentes poblaciones de vacuno).

Year	Author	Method	Population	N	Sex	F p.100	G
1923	Wright	W-P	Shorthorn	64	fm	40.95	13
1925	Mcphee and Wright	2l-RP	British Shorthorn	100	m/fm	26.9	>10
1937	Willham	2l-RP	Hereford / USA	500	m/fm	8.1	12.9
1943	Stonaker	2l-RP	Aberdeen-Angus	400	m/fm	11.3	17
1951	Stonaker	W-P	Hereford (1 herd)	43	m/fm	30.7	5
1960	Barker and Davey	2l-RP	Poll Heref./Austral.	185	f	1.8	5.3
1960	Davey and Barker	2l-RP	Heref./Austral.	153	f	2.6	12
1963	Watson	W-P	Welsh Black	128	m	2.3-2.8	4
				166	f	0.8-1.2	
1963	Rendel	W-P	Red Cattle/Swede.	1287	m	2.2	5
1977	Özkütük and Bichard	4l-RP	Hereford/GB-Irl.	100	m/f	5.7	1
1980	Kidd *et al.*	OEH	Retinto Cattle	166		8.0	
			De Lidia Cattle	124		17.0	
			Mertolenga	149		5.0	
1981	Machbert	Mal.	Gelbvieh/FRG	321	m	0.6	
1983	Reichenbach	W-P	Gelbvieh/France	52	m	1.0	5
				50	f	1.8	5
1984	Hudson and VanVleck	R-M	Holstein-Frs.	1474995	f	0.3	
			Brown Swiss	18516	m	0.5	
			Ayrshire	50688	m	2.9	
			Guernsey	61733	m	0.4	
			Jersey	81639	m	0.5	
1988	Diers and Langenberg	W-P	Red Cattle/Westf.	105	m	0.4	3
1990	Bollmeier *et al.*	W-P	Brown Cattle	300	m	0.17-0.39	3
			Württemberg			0.56-0.92	5
1990	Schmidt	W-P	Red Cattle/Wsetf.	594	m/f	0.12-0.38	3

Year: Year of the publication.
Method: Method of the inbreeding calculation: 2l-RP: Two lines random pedigree; 4l-RP: Four lines random pedigree; W-P: Using the Whole pedigree information; Mal.: Malecot method (1948); R-M: Relation matrix sire-maternal grandsire; OEH: Estimation by a comparison of the observed and expected heterozigosity at polymorphic systems.
N: Size of the studied sample; Sex: Sex of the sample animals (m=male, fm=female); G: Number of ancestral generations considered

on inbreeding made with the 2-line random pedigree method, we find quite high values. For example, McPhee and Wright (1925) investigated a sample of one hundred animals (male and female) of British Shorthorn with more than ten ancestral generations and they reported a mean of F=26.9 p.100. Willham (1937) worked with 500 animals (also males and females) from the Hereford population in the USA. He found a mean of F=8.1 p.100 with 12 traced-back generations. Stonaker (1943) reported a F=11.3 p.100 in 400 Aberdeen-Angus males and females with 17 ancestral generations investigated.

These values are explained by several reasons. At the time, these breeds were still in the consolidation stage and very closely-related animals were mated. Also, all these studies were made considering more than ten ancestral generations.

CONCLUSIONS

If we compare our results with those obtained for other beef breeds at present our mean current inbreeding coefficient is the highest.

The higher value estimated by Kidd *et al.* (1980) might be explained two ways: a genetic isolation of the herds, as they suggested in their paper, and present inbreeding from mating of closely related animals. An overview of the breeding schemes confirm these matters, taking into account that the breeders tend to use a very limited number of sires.

In this study only a small approach has been made with a sample of animals from Andalusia and we must not forget that this breed is found in an extensive area of S.W. Spain and Eastern Portugal. However these figures convince us of the need for a complete study of the Retinto population.

It is absolutely necessary to estimate the noncurrent inbreeding coefficient which appears to be very high and to establish the relationship among animals involved in the breeding program.

Knowledge of the inbreeding rate and the effective number of sires will slow us in estimating the necessary pressure in the selection of the best bull and cow sires. Also the 1/29 chromosomic translocation-wide-spread in this population along with the cytogenetic test could be avoided.

ACKNOWLEDGEMENTS

This work was supported in part by the Andalusian Government and the project *Estimación insesgada de parámetros genéticos y determinación de alteraciones cromosómicas para una correcta selección en ganado vacuno Retinto* from C.I.C.Y.T. (GAN-89669). We wish to thank Mr. Manuel Beteta and Mrs. Belén Alvarez for his generous help and The Retinto Breeders Association for the contribution of data.

REFERENCES

Barker, J. and G. Davey. 1960. The breed structure and genetic analysis of the pedigree cattle breeds in Australia. II. The Poll Hereford. *Aust. J. Agric. Res.* 11: 1072-1100.

Bollmeier, S. 1990. Inzucht, Verwandtschaft und Genanteile in wüttembergischen Braunvieh. Dissertation. Hannover.

Bollmeier, S., M. Mayer and D. Simón. 1990. "Auszucht" gegen Inzucht. *Tierzuchter* 42: 244-245.

Davey, G. and J. Barker. 1960. The breed structure and genetic analysis of the pedigree cattle breeds in Australia. III. The Hereford. *Aust. J. Agric. Res.* 14: 93108.

Diers, H. and R. Langenberg. 1988. Inzucht other Outcross - wohin steuern die Rotbunten?. Top Agrar. Top Spezial 2 /1988, 20-23.

Hudson, G. and L. VanVleck. 1984. Inbreeding of artificial breed dairy cattle in the North-eastern United States. *J. Dairy Sci.* 67: 161-170.

Kidd, K., W. Stone, C. Crimella, C. Carenzi, M. Casati and G. Rognoni . 1980. Inmunogenetic and population genetic analysis of Iberian Cattle. *Anim. Blood Groups Biochem. Genet.* 11:21-38.

Machbert, B. 1981. Verwandtschats-und Inzuchtverhäaltnisse der Besamungsbullen bei Deutschen Gelbvieh. Giessen, Justus-Liebig-Univ., Fachber. Veterinärmedizin und Tierzucht, Diplomarbeit.

Malecot, G. 1948. Lés Mathématiques de l'Hérédité. Masson et Cie, Paris.

Mcphee, H. and S. Wright. 1925. Mendelian analysis of the pure breeds of livestock. IV. The British Dairy Shorthorns. *J. of Heredity*. 17: 397-401.

Özkütük, K. and M. Bichard. 1977. Studies of pedigree Hereford cattle breeding. I. Herdbook analyses. *Animal Prod.* 24: 1-13.

Quaas, R. 1976. Computing the diagonal elements and inverse of a large numerator relationship matrix. *Biometrics* 32: 949-953.

Reichenbach, F. 1983. Der Anteil des Roten Dänischen Milchviehs sowie Inzuchtund Verwandtschaftsverhältnisse beim Deutschen Gelbvieh. Diplomarbeit TU Munchen, Weihenstephan.

Rendel, J. 1963. An example of changes in the genetic composition of a cattle breed due to one popular bull. *Acta Agric. Scand.* 13: 227-238.

Schmidt, T. 1990. Analyse der westfälichen Rotbuntzucht bezüglich Inzucht, Verwandtschaft, generationsintervall und Zuchtfortschritt. Diplomarbeit TIHO Hannover - Rheinische Friedrich-Wilhems Univ. Bonn.

Stonaker, H. 1943. The breeding structure of the Aberdeen-Angus breed. *J. of Heredity*. 34: 323-328.

Stonaker, H. 1951. A unique herd of Hereford cattle. *J. of Heredity*. 42: 207-209.

Watson, J. 1963. Inbreeding arising through artificial insemination and natural service in Welsh Black cattle. *Animal Production* 5: 209-214.

Willham, O. 1937. A genetic history of Hereford cattle in the Unites States. *J. of Heredity*. 28: 283-294.

Wright, S. 1923. Mendelian analysis of the pure breeds of livestock. II. The Duchess Family of Shorthorn as breed by Thomas Bates. *J. of Heredity*.14: 405-422.

Recibido: 6-9-94. Aceptado: 20-12-94.