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GROWTH LIMITATIONS OF SUCKLING RABBITS. PROPOSAL OF A METHOD TO EVALUATE THE NUMERICAL PERFORMANCE OF RABBIT DOES UNTIL WEANING.

J.S.Vicente and F. García-Ximénez

Universidad Politécnica de Valencia
Camino de Vera, 14, 46071 Valencia (Spain)

ABSTRACT

Nine hundred and thirty eight litters from four selected strains were controlled. The objectives were both to study growth limitations in suckling rabbits during the lactation period caused by the number of offspring and the does capacity to nourish them, and to apply the criterium proposed by García-Ximénez and Vicente (1991), when evaluating the numerical uterine capacity in rabbit does, on the lactacional period, in view to estimate the numerical performance. The results obtained in the studied strains indicated that the does from the strains B, V and R showed limitations in the litter weight at birth, the chances of increasing the mean litter size at birth in these strains could implie a reduction in the mean live weight. In addition, limitation on the lactational ability was observed in all strains. If the number of suckling rabbits is increased more than the lactational performance this causes a weight reduction of the suckling and consequently it could affect the survival rate even during the fattening period. The minimum mean weight estimated for each lactational weeks is showed by strain and parity.

INTRODUCTION

Survival and growth capacity of individual pups is conditioned by the number of offspring during lactation. In spite of the physiological mechanisms by which the does adapt milk production to the number of offspring, milk production capacity is limited. So that the greater the number of offspring, the greater is the total weight of litter tends to be, but the individual growth rate of the pups, and consequently their survival capacity tends to decrease (Torres et al., 1986). However, when the number of surviving pups is higher at weaning their total litter weight is also higher at end of the fattening period. This fact is relevant if the litter (and not the development of individual rabbit) is considered as a meat production unit.

The aim of this paper is to study growth limitations in suckling rabbits during the lactation period caused by the number of offspring and the does capacity to nourish them. Given that the situation is similar to that observed during gestation at the postplacentational stage, the same methodology is used as that which has been proposed by García-Ximénez and Vicente (1991) when estimating the minimum survival weight at birth, but applied, in this instance, to the weights of live pups at birth and then every week during lactation.

MATERIAL AND METHODS

Four selected rabbit strains were used in this study. Two of them were selected on litter size at weaning, strain A (White New Zealand) and strain V (Synthetic breed). The other two, strains B (California) and R (Synthetic breed) were selected on growth rate from weaning to slaugther (28-77 days).

The data was obtained in 1983. Nine hundred and thirty eight litters were controlled (A -278-, B -103-, V -303- and R -255-), and the following variables were recorded for each one:

a.- Strain (V, A, B and R)

b.- Parity (primiparous - PRI- and multiparous -MUL-).

c.- Number of total pups at birth (NTP)

d.- Number of live pups at birth (NLP)

e.- Weight of live pups at birth (WLP)

f.- Number (NS) and weight (WS) of suckling rabbits:
 at 1st lactational week (NS1, WS1)
 at 2nd lactational week (NS2, WS2)
 at 3th lactational week (NS3, WS3)
 at 4th lactational week (NS4, WS4)

g.- Number of rabbits at end of the fattening period (NFP).

h.- Weight of rabbits at end of the fattening period (WFP)

The number of total pups at birth (NTP) was analyzed by an analysis of variance and the number of live pups at birth (NLP) by an analysis of variance-covariance of which the main effects were strain and parity and where the covariate was NTP.

The weight of live pups (WLP) and litter weight for each lactational week (WS1, WS2, WS3 and WS4) and at the end of the fattening period (WFP) were analyzed by an analysis of variance-covariance, of which the main effects were strain (A, B, V, R) and parity (PRI, MUL) the correspondent numbers of live pups (NLP) or suckling rabbits (NLP, NS1, NS2, NS3, NS4, NFP) were used as covariate.

The possible maternal limitations on the total weight of live pups at birth (WLP) and suckling rabbits (WS1, WS2, WS3, WS4, WFP) were tested by the significance of quadratic term when these variables were fitted to quadratic regression equations, the independent variables were the number of total live pups at birth (NTP) and the number of live pups (NLP) and suckling rabbits (NS1, NS2, NS3, NS4) respectively. The regression was fitted between the litter weight and the number of suckled rabbits during the previous week, because these pups represent those which compete among themselves in the week being analyzed.

$$WS_i/NS_i = b_o + b_1 \times NS_{(i-1)} + b_2 \times NS_{(i-1)}^{2}$$

Brody's post-inflection exponential function was used to estimate the maximum mean weight of the litters only when the coefficient of the quadratic term was significant (P<0.05).

$$WS_i = A(1-be^{-kNS}(i-1))$$

In a previous work (García-Ximénez and Vicente, 1991) it was established that the relationship between mean weight at birth of live pups and the total number of pups at birth fitted adequately to the hiperbolic equation (Y=A+B/X). The A parameter of hiperbolic equation provides an estimate of minimum weight of survival at birth. The same model was applied in the present work to estimate the minimum survival weight of pups and suckling rabbits in each lactational week.

$$MWS_i = A + B/NS_{(i-1)}$$

MWS_i: mean weight at each lactational week (WS_i/NS_i)

RESULTS AND DISCUSSION

Significant differences were found in the number of total and live pups at birth (NTP, NLP) between strains. The V and R strains had a higher NTP and NLP at birth (8.4, 7.9 and 8.0, 7.7 respectively) than the A Strain (7.1 and 6.6, P<0.05, Table 1). While, the only differences were observed in NTP between parity (7.2 in primiparous does and 8.5 in multiparous does). This difference is due to the already well described differences in reproductive performance which affect the ovulation rate (Hulot and Matheron, 1981; García, 1982; García-Ximénez and Vicente, 1992) because it defines the maximum limits of litter size. However, the different reproductive performance did not directly affect the number of live pups, as was clear when they were analyzed using the covariate NTP. So the perinatal losses were not influenced by parity.

In the first and 4th lactational week, the differences in the litter weight between strains were not significant when they were analyzed at constant litter size, this fact could be explained by the different litter size in each strain (Table 1). In the other lactational weeks (WS2 and WS3), the V and R strains showed the greatest litter weights, in spite of using the corresponding covariates (NS2 and NS3, table 1, P<0.05). This could be due to differences either in the maternal genotype (which implies for example a better lactational performance) and/or in the genotype of the suckling rabbits (which determine better feed efficiency) during the lactational period. However, these differences did not reach statistically significance in litter weights when the pups began to consum solid food (during 4th lactational week and fattening period). So, the observed differences could be due exclusively to better lactational performance by the V and R does.

Lebas (1969) and Mendez et al (1986) proposed that the weight of litter size at the end of the third lactational week can be considered as representative of milk production, so the milk production of the does from the V and R strains was greater than the A and B strains (Table 1).

Significant differences were observed in litter weight at birth and during all lactacional weeks between primiparous and multiparous does, these differences were not explained by the different litter size. If the minor reproductive performance from primiparous does negatively affected the total weight of live pups at birth (362 g. vs 403 g., PRI and MUL respectively P<0.05, Table 1), the lowest lactational performance of the primiparous does also negatively affected the growth of the litters during the four lactational weeks (Table 1). These differences disappear during the fattening period, in which all weaned rabbits were feed "ad libitum", resulting in the disappearance of competition between them.

Table 2 shows the parameters of quadratic regression used to evaluate the maternal limitations on suckling rabbit growth.

Only the A strain (with the minor litter size at birth) did not present maternal limitations on the total weight of live pups at birth. However, all strains showed maternal limitations on total litter weights during the lactational period. This maternal effect disappears during the fattening period in all cases. When data was analyzed for primiparous and multiparous does, maternal limitations during lactational period in primiparous does had a negative effect on the growth of pups until the end of the fattening period (Table 2).

It can be experimentally observed that the rabbits from minor litter sizes (2 or 3) reached weaning weights of about 700-1000g., while in larger litter sizes (7 to 10) the weaning weigths were about 350-500g. The obtained results confirm that the does ability for milk production and the competition between suckling rabbits limits the maximum expression of the genetically determined ability for growth of suckling rabbits.

Table 3 shows the parameter of the function of Brody. The A parameter is a estimate of the maximum total weight of the litters corresponding to each week. If the total weight of litters is limited by a maternal effect (limited milk production), this limit determines that when the litter size increases the individual weight of suckling rabbits consequently decreases and their chances of survival are reduced. Estany et al. (1986) and Rochambeau (1988) observed that postnatal survival is reduced when the number of pups born is raised. In this study, the partial losses during lactational period were 12±1 % in litter sizes lower than 11 and about 25±3 % in greater litter sizes (12 to 15). Only 13 cases of total losses of litter were observed (11 in primiparous and 2 and multiparous does). These were distributed from litter sizes of 2 to 11.

If we could determine the minimum mean weight of survival at birth and during lactational period, we could be able to evaluate the posibilities of increasing litter size at birth and the ability of does to support their litter until weaning. Garcia-Ximénez and Vicente (1991) proposed that the minimum mean survival weight at birth could be estimated by the A hyperbolic regression coefficient between individual mean weight of live pups and the number of total pups at birth. In this study this concept was not only applied at minimum mean weight at birth but also to each lactational week.

The parameters of hyperbolic regression are shown in Table 4. The minimum mean weight of survival can be considered as a populational parameter, but not the ability of does to support gestation or lactation. Based on the relationship which exists between the number of pups and total litter weight and individual mean weight of pups, and knowing the minimum mean weight of survival at birth and in each one lactational week it is possible to estimate the expected mean number of live pups or suckling rabbits from any individual doe (by the relation between the total litter weight and an estimate of the minimum mean weight). This could then be used to evaluate the reproductive and lactational numeric performance of does. In addition, the posibilities of increasing both the litter size at birth and of supporting a greater number of pups during the lactational period it could be evaluated. However, this parameter must be estimated for each strain and each generation, because it could change as a result of selection process or management improvement. Moreover, estational variations can occur. These events are not important in practice because the data is easy to obtain.

In conclusion, the criterium used in this study may be useful in the evaluation of the lactational and reproductive performance of does. The results obtained in the studied strains indicated that the does from the strains B, V and R showed limitations in the litter weight at birth, the chances of increasing the mean litter size at birth in these strains implie a reduction in the mean live weight of pups in subsequent generation. In addition, limitation on the lactational ability was observed in all strains. If the number of suckling rabbits is increased more than the lactational performance this causes a weight reduction of the suckling and consequently it could affect the survival rate even during the fattening period.

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Table 1.- Characteristics of litters.

	STRAIN				PARITY		Covariate
	A	B	V	R	PRI	MUL	Coefficient
NTP	7.1 0.1^{b}	7.6 0.2^{ab}	8.4 0.1^{a}	8.0 0.1^{a}	7.2 0.1^{b}	8.5 0.1^{a}	—
NLP	6.6 0.1^{c}	7.0 0.2^{b}	7.9 0.1^{a}	7.7 0.1^{a}	6.8 0.1	8.0 0.1	0.95***
WLP(g)	341 7^{c}	362 11^{bc}	417 6^{a}	393 7^{ab}	362 5^{b}	403 5^{a}	39***
WS1(g)	833 15	843 25	953 12	914 15	855 10^{b}	938 12^{a}	85***
WS2(g)	1379 24^{c}	1356 40^{c}	1564 18^{a}	1492 23^{b}	1390 16^{b}	1549 18^{a}	125***
WS3(g)	1952 34^{b}	1860 57^{b}	2180 26^{a}	2110 33^{a}	1931 23^{b}	2197 25^{a}	161***
WS4(g)	3090 65	2982 104	3483 48	3449 57	3108 44^{b}	3509 44^{a}	324***
WFP(g)	8471 304	9058 508	11409 272	11276 297	9681 227	10856 238	2009***

Means ± standard error.

^{a,b,c}Values in rows with different superscripts differ statistically ($P< 0.05$).

*** Statistical significance of covariate coefficient ($P<0.001$)

Table 2.- Limitations of pups growth at birth and during lactational period. Parameters of quadratic equation.

STRAIN	No.	DEP.	IND.	b_o±	se	b_1±	se	b_2±	se	R^2
A	278	WLP	NLT	63	35	42	10	-0.4	0.7	0.54
	275	WS1	NLP	161	62	141	20	-5.2	1.5***	0.52
	270	WS2	NS1	345	96	219	32	-7.4	2.6**	0.55
	259	WS3	NS2	422	124	356	43	14.3	3.5***	0.59
	239	WS4	NS3	219	227	664	79	-25.3	6.5***	0.64
	255	WFP	NS4	-83	1198	1706	431	-12	36	0.52
B	103	WLP	NLT	-76	61	87	16	-3.5	1.0***	0.56
	102	WS1	NLP	41	125	171	36	-7.3	2.5**	0.45
	102	WS2	NS1	-16	160	343	55	-17.8	4.4***	0.58
	100	WS3	NS2	138	193	442	68	-22.7	5.8***	0.58
	99	WS4	NS3	-336	334	879	120	-46.5	10.2***	0.64
	98	WFP	NS4	-1140	1913	2349	705	80	61	0.45
V	303	WLP	NLT	30	46	63	11	-1.8	0.7**	0.48
	302	WS1	NLP	140	80	172	21	-8.0	1.3***	0.40
	300	WS2	NS1	459	126	219	36	- 8.7	2.5***	0.40
	294	WS3	NS2	591	200	344	58	-15.9	4.1***	0.33
	284	WS4	NS3	355	308	694	93	-32.8	6.7***	0.44
	297	WFP	NS4	-227	1394	2040	430	-45	32	0.46
R	255	WLP	NLT	35	36	56	9	-1.3	0.6*	0.58
	255	WS1	NLP	74	75	175	20	-7.8	1.3***	0.43
	251	WS2	NS1	228	110	253	33	-9.7	2.4***	0,56
	247	WS3	NS2	266	157	406	49	-18.4	3.6***	0.53
	237	WS4	NS3	44	245	751	72	-34.2	5.1***	0.58
	248	WFP	NS4	-661	1384	2261	440	-63	34	0.50

PARITY	No.	DEP.	IND.	b_o±	se	b_1±	se	b_2±	se	R^2
PRI	487	WLP	NTP	8	25	60	7	-1.4	0.5**	0.61
	482	WS1	NLP	75	44	170	13	-7.4	1.0***	0.56
	475	WS2	NS1	224	69	265	23	-11.9	1.8***	0.56
	463	WS3	NS2	251	97	424	33	-22.3	2.7***	0.54
	4•9	WS4	NS3	-19	172	765	56	-37.4	4.4***	0.57
	461	WFP	NS4	- 891	834	2234	298	-58	25*	0.54
MUL	451	WLP	NTP	63	35	50	9	-1.1	0.5*	0.47
	451	WS1	NLP	133	66	167	17	-7.5	1.1***	0.35
	448	WS2	NS1	278	94	259	28	-10,5	2,0***	0.50
	437	WS3	NS2	348	124	407	38	-18,5	2,8***	0.50
	417	WS4	NS3	170	194	743	60	-34,8	4.5***	0.60
	437	WFP	NS4	-296	1228	1892	382	-30	28	0.46

se: standard error

$^{***}P<0.001$. $^{**}P<0.01$. $^{*}P<0.05$

No.= Number of litters

Table 3.- Parameters of Brody's function.

STRAIN	DEP.	A±se		b±se		k±se		R^2
A	WS1	1255	112	0.96	0.07	0.17	0.09	0.53
	WS2	2366	323	0.89	0.05	0.13	0.04	0.55
	WS3	3068	275	0.92	0.06	0.17	0.04	0.59
	WS4	5515	618	1.00	0.06	0.15	0.04	0.65
			+60H					
B	WLP	538	58	1.30	0.25	0.20	0.06	0.56
	WS1	1193	153	1.06	0.20	0.20	0.08	0.46
	WS2	1769	133	1.21	0.21	0.29	0.08	0.58
	WS3	2494	203	1.08	0.15	0.27	0.06	0.59
	WS4	4383	406	1.17	0.10	0.25	0.06	0.64
V	WLP	670	84	1.04	0.12	0.13	0.04	0.48
	WS1	1108	36	1.13	0.16	0.29	0.05	0.35
	WS2	2039	138	0.87	0.09	0.19	0.05	0.41
	WS3	2617	129	0.98	0.17	0.27	0.07	0.34
	WS4	4718	377	0.97	0.11	0.19	0.05	0.43
R	WLP	745	115	1.02	0.07	0.10	0.03	0.59
	WS1	1142	56	1.08	0.13	0.24	0.05	0.42
	WS2	2153	167	0.97	0.07	0.17	0.04	0.56
	WS3	2816	163	1.00	0.09	0.22	0.04	0.53
	WS4	4751	282	1.08	0.10	0.21	0.04	0.57

PARITY	DEP.	A±se		b±se		k±se		R^2
PRI	WLP	754	101	1.05	0.05	0.10	0.03	0.61
	WS1	1188	56	1.01	0.06	0.20	0.03	0.56
	WS2	1929	95	0.96	0.06	0.20	0.03	0.56
	WS3	2464	84	1.02	0.08	0.27	0.04	0.54
	WS4	4393	204	1.11	0.08	0.24	0.03	0.56
	WFP	18308	2075	1.21	0.10	0.18	0.04	0.32
MUL	WLP	699	92	1.00	0.07	0.11	0.03	0.47
	WS1	1114	36	1.13	0.13	0.28	0.04	0.35
	WS2	2114	114	0.96	0.07	0.19	0.03	0.50
	WS3	2856	113	1.01	0.08	0.23	0.03	0.51
	WS4	4776	195	1.09	0.07	0.22	0.03	0.60

se: standard error

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Table 4.- Parameters of hyperbolic equation. Estimation of the minimum mean weight of survival.

STRAIN	DEP.	A±se		B±se		R^2
A	MWP	37	3	99	16	0.31
	MWS1	113	3	165	14	0.34
	MWS2	186	6	327	24	0.41
	MWS3	264	9	508	36	0.44
	MWS4	489	15	441	61	0.18
B	MWP	41	2	84	14	0.25
	MWS1	102	5	225	27	0.40
	MWS2	174	10	341	46	0.35
	MWS3	264	14	361	53	0.32
	MWS4	489	23	275	67	0.10
V	MWP	38	2	115	4	0.48
	MWS1	95	3	275	16	0.50
	MWS2	144	5	560	28	0.58
	MWS3	162	9	1080	51	0.61
	MWS4	359	12	1074	57	0.48
R	MWP	43	1	66	16	0.30
	MWS1	105	3	180	14	0.38
	MWS2	181	5	270	25	0.31
	MWS3	257	8	402	38	0.32
	MWS4	434	12	590	60	0.29

PARITY	DEP.	A±se		B±se		R^2
PRI	MWP	42	2	72	12	0.27
	MWS1	103	2	190	10	0.48
	MWS2	175	4	338	17	0.47
	MWS3	241	6	521	27	0.45
	MWS4	444	10	549	43	0.28
MUL	MWP	36	2	110	15	0.27
	MWS1	107	2	198	14	0.31
	MWS2	172	5	380	25	0.36
	MWS3	255	7	514	34	0.35
	MWS4	444	11	592	53	0.23

se:standard error