EFFECT OF REPRODUCTIVE RHYTHM AND FRESH CHICORY (*CICHORIUM INTYIBUM L.*) INCLUSION IN THE PRODUCTIVE PERFORMANCE OF RABBIT DOES

Cossu M.E.[1]*, Cumini M.L.[1], Etcheluz L[1]., Rolla C.[2]

[1]Departamento de Producción Animal, Fac. Agronomía, UBA, Av. San Martín 4453, (1417) Buenos Aires, Argentina
[2]Eccorabit, Colón 98, Cañuelas, Buenos Aires, Argentina
*Corresponding author: mcossu@agro.uba.ar

ABSTRACT

The effect of two reproductive rhythms (11 or 18 d *post-partum*) and dietary inclusion (LCh) or not (L) of fresh chicory (*Cichorium intyibum*) on productive performance of rabbit does was assessed. Four groups of 20 multiparous selected New Zealand x California does were submitted to the following diets and reproductive rhythms: L11: commercial lactating diet, 11 days *post partum*; L18: commercial lactating diet, 18 days *post partum*; LCh11: commercial lactating diet+chicory, 11 days *post partum*; LCh18: commercial lactating diet+chicory, 18 days *post partum*. Females were inseminated for four consecutive cycles. Within each experimental group, the number of suckling kits was adjusted to 7-8 per litter. Kits were nursed once a day and were weaned at 32 days. Fertility rate, number of kits born alive, pre-weaning mortality, litter size at weaning, weight of kits at 21 days and weight of rabbits at weaning were recorded during the four cycles. Data were analysed according to a randomised complete design using PROC GLM; the model evaluated the fixed effects of reproductive rhythm, diet and their interaction. Means were compared by Tukey test ($P<0.05$). The presence of statistical interaction between reproductive rhythm and diet was high. Chicory inclusion significantly increased the fertility rate, the number of kits born alive and kit weight at 21 days in the 11 d *post partum* groups but did not influence these data in the 18 d *post partum* groups. At weaning, the total weight of rabbits of four reproductive cycles was positively influenced by chicory inclusion (37.5 kg vs. 30.1 kg for LCh and L respectively; $P<0.01$) and also by the reproductive rhythm, even if less significantly, (36.2 vs. 31.5 kg for 18 d and 11 d respectively; $P<0.05$). In conclusion, chicory inclusion improved the productive performance of does submitted to the standard 11-d reproductive rhythm; for the semi-intensive 18-d group, chicory improved only the weight of rabbits at weaning. L11 does showed the poorest results making evident the progressive reduction of body reserve due to the partial overlapping of pregnancy and lactation.

Key Words: Rabbit does, Chicory, Reproductive rhythm, Productivity.

INTRODUCTION

The greater intensification of the reproductive rhythm increases the competition between the mammary glands and foetuses (Fortun and Lebas, 1994) and it does not take care of the reproductive physiology of the does (Castellini *et al*., 2003). The requirements of reproductive rabbit does increase considerably and, if the needs are not well covered, body condition, life expectancy, health and efficiency index of the rabbit farm, become worse (Xiccato *et al*., 1995; Parigi Bini *et al*., 1989, 1996; Fortun-Lamothe, 2006). The extensive reproductive rhythm improve the body condition of does (Dal bosco *et al*., 2003); particularly, the post weaning rhythm improve receptivity and fertility without modifying the litter size but it shows lower production and increases the risk of fatness if compared with a 11 d reproductive rhythm (Castellini *et al*., 2006).

Argentine rabbit production system is based on natural or artificial insemination of does around 11 days after parturition (standard reproductive rhythm) and on selling 2.3-2.5 kg live weight rabbits at 70-90 days of age. Mostly of the rabbit breeders have small farms of 50-100 females, in spite of the estimation of 300 females as economical production unit. For these small farms, the application of intensive reproduction rhythms, imitating the model of the European commercial farms, without considering the differences in applied technology, sanitary status and quality of diets, the economical and productivity results are poor and not always compatible with the farm sustainability.

In our country, scientific researches about rabbit does productivity are limited and insufficient to satisfy the rabbit farmer's information requests. Particularly, there do not exist national publications about reproductive performance of rabbit does, kits pre-weaning mortality and milk production capacity of animals breed under semi intensive reproductive rhythm or with fresh forage inclusion in the diet. Chicory is a normal vegetable crop, destinated to human consumption in Argentine. One of the most concentrated sources of fructo oligosaccharides and inulin is the chicory plant (Van Loo *et al*., 1995). The fructo oligosaccharides (inulin, oligofructose) additionated in rabbit diets have positive effects on caecal fermentation and health of rabbits (Maertens *et al*., 2004).

The purpose of the experimental work is, on one hand, to compare the productive performance of does under standard or semi-intensive reproductive rhythm and, on the other hand, to assess the influence of chicory inclusion on welfare, reproductive performance and milk production of selected multiparous rabbit does.

MATERIALS AND METHODS

Performance assay

Rabbit does were bred in family cages at a commercial rabbit farm, placed in Buenos Aires province. Four groups of 20 multiparous (5-7 kindling) NZxC rabbit does were submitted to the following diets and reproductive rhythms: L11: commercial lactating diet, 11 days *post partum*; L18: commercial lactating diet, 18 days *post partum*; LCh11: commercial lactating diet + chicory, 11 days *post partum*; LCh18: commercial lactating diet +chicory, 18 days *post partum*. All animals were fed ad *libitum* with a commercial lactating diet (ED: 2597 kcal/kg, PC: 17.8%; ADF: 12.6%). Fresh chicory (300 g chicory/d/cage; 9.34% DM, CP: 28.8% DM, DE: 2558 kcal/kg DM) was added to half of the does ('Ch' groups) once a day during four consecutive reproductive cycles. Individual commercial diet consumption was recorded twice a week; consumption of chicory was estimated as a complete consumption because of the absence of chicory remainders in the cages.

Animals and measurements

Females were natural inseminated at 11 o 18 days after parturition for four consecutive cycles. The number of suckling kits was adjusted to 7/8 per litter, inside each experimental group, 24 hours after birth. Kits were nursed once a day and were weaned at 32 days. The fertility rate was calculated as the percentage of the number of parturitions/number of natural inseminated does. Litter size was recorded at kindling, 21 and 32 days of age. The number of live born, pre-weaning mortality, litter size at weaning, weight of kids at 21 days and weight of rabbit at weaning was estimated during the 4 cycles. Data were analysed according to a randomised complete design using PROC.GLM (SAS®, 1996); the model evaluated the fixed effects of reproductive rhythm (RR), diet (D) and their interaction. Means were compared by Tukey test ($P<0.05$).

Diet quality analyses were performed according to A.O.A.C (1984) and fibre content was determined by Goering and Van Soest (1970).

RESULTS AND DISCUSSION

The effects of 11 d or 18 d *post partum* reproductive rhythm and chicory inclusion on the does performance during four consecutives cycles were described in Table 1. The fertility rate showed significant interaction between the reproductive rhythm and diet. The chicory inclusion improved the fertility rate in the LCh11 group (P<0.05) respect the L11 group but did not show any influence between the L18 and LCh18 females.

Table 1: Effect of reproductive rhythm and chicory inclusion on some productive traits of pluriparous rabbit does during four consecutive cycles

	Experimental groups				Probability			RMSE
	L11 N=20	L18 N=20	LCh11 N=20	LCh18 N=20	Reproductive Rhythm	Diet	RR x D	
Fertility (%)	0.63	0.74	0.82	0.74	0.7619	0.0173	0.0173	0.18
Live born/parturition/doe	5.13	6.66	7.06	6.65	0.2395	0.0460	0.0433	2.12
Total live born/doe	20.50	26.65	28.42	26.60	0.2395	0.0460	0.0433	8.49
Total died born/doe.	0.85	0.65	1.79	1.25	0.5660	0.2023	0.8251	2.52
Rabbit Weaning/doe	18.25	23.15	25.21	24.50	0.1858	0.0101	0.0790	7.03
Rabbit Weaning/parturition	91	116	126	123	0.1858	0.0101	0.0790	35.2
Mortality (%)	10.81	9.27	9.89	7.38	0.5404	0.5692	0.9354	12.94
Kit weight at 21d (g)	379	393	385	380	0.6962	0.7587	0.4484	0.05
Total kit weight at 21d/doe (kg)	6.94	8.94	9.63	9.30	0.1686	0.0137	0.0580	2.69
Kit weight at 32d (g)	722	766	744	785	0.0492	0.3426	0.9334	0.09
Total kit weight at 32d/doe (kg	13.01	17.13	18.48	19.04	0.0375	0.0009	0.1061	4.84

RMSE: Root Mean Square Error

The number of live born kits also showed significative interaction RR x Diet with the same trend as the fertility rate: the number of live born in each cycle was positively influenced (P<0.05) by chicory diet in LCh11 respect L11 but diet, did not influence (P>0.05) the L18 and LCh18 groups (Figure 1).

L11 group presented the less number of live born kits in the three cycles in which it also showed the less fertility rate; in the LCh11 group, chicory probably improved the live born number because of the better welfare status of females, due to fitoesterol-inulin presence. For L18 and LCh18 females, chicory inclusion did not significantly influenced the fertility and the live born number because of the longer period between parturition and insemination could be enough to recover energy depots and the adequate body condition to support the successive reproduction cycle. Castellini *et al*. (2006) showed that the post weaning rhythm (27 days *post partum*), compared to insemination at 11 days, seemed more adapted to doe reproductive physiology (higher fertility) and maintained better equilibrium of body weights and fat depots. These authors did not found any difference in the live born number for the two groups.

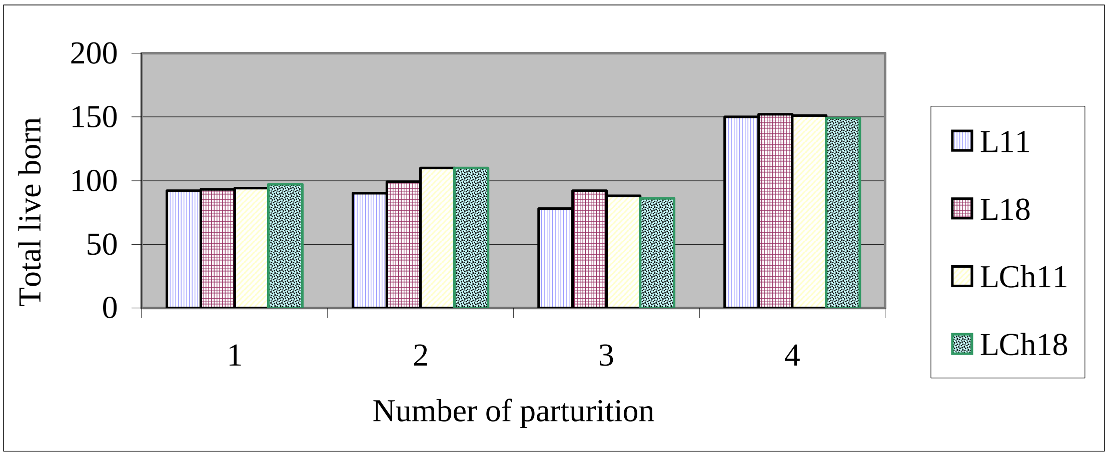

Figure 1: Effect of reproductive rhythm and chicory inclusion on the number of live born for each productive cycle

No differences were observed in the mortality at *partum* and the pre-weaning mortality. Experimental data were similar to the average obtained in national commercial farms (De Mayolas, 2003).

For the number of rabbits at weaning, the RR x D interaction was significative at 8% (P=0.0790); the number of weaned rabbits was higher in chicory groups respect control diet group (more 16.7% for

LCh11 and LCh18 respect L11 and L18; P<0.05), due to the higher live born number for LCh11 plus LCh18 and the same mortality for all the experimental groups.

The total kit weight at 21 days that estimate the does milk production, showed RR x D interaction of 6% (P=0.0580). Chicory inclusion improved milk production of does submitted to the standard rhythm (P<0.05) but this advantage was not significant in the semi-intensive rhythm groups.

The rabbit weight at weaning was influenced not only by the diet (P<0.001) but also by the reproductive rhythm (P<0.05). Chicory inclusion positively influenced the kilograms obtained at weaning (752 vs. 603 kg for LCh and L respectively; P<0.001%). The semi-intensive reproduction rhythm also improved the kilograms obtained at weaning but less significantly (723 vs. 632 for 18 d and 11 d respectively; P<0.05). Castellini *et al*. (2007) showed higher weight of kits at weaning (610 vs. 599 g for ‘post weaning’ and ‘standard’ rhythm) but the difference was not significant (P>0.05).

Total kilograms obtained at 21 days of age was higher for LCh 11 group while total kilograms obtained at 32 days of age was higher for LCh 18d. LCh 11d better weight at 21 days (mostly milky diet) was probably due to fitoesterols activity in stressed does (standard production system). The longer period between parturition and insemination in the semi-intensive rhythm seemed to be enough to obtain good milk productions in the does, independently of the presence of fitoesterols in the diet. The higher weight of LCh 18 rabbits at weaning was probably due to the longer milk production curve, after the maximum pick (18-21 days), respect LCh 11 group; LCh 18 kits consumed milk + concentrate diet with a larger proportion of milk than LCh 11 kits. L18 group showed lower values than LCh 18 and 11; this could demonstrate the influence of chicory (fitoesterols) inclusion in the increase of milk production of the does, independently from the reproductive rhythm adopted.

Total feed intake (kg TQ) of the 4 experimental groups and chicory intake (kg TQ) for LCh groups were presented in Table 2. The intake of commercial lactating diet showed significant RR x D interaction (P=0.0317). There was not a clear influence of the diet (53.9 vs. 53.3 kg average for L and LCh respectively) and of the reproductive rhythm (53.5 vs. 53.7 kg average for 11d and 18d respectively) on the feed intake. Females of LCh groups did not decrease the concentrate intake because of the chicory inclusion, probably due to its low dry matter content and the limited quantity offered to the does.

Table 2: Chicory and concentrate intake (kg TQ) of does during four reproductive cycles

	Experimental groups				Probability			RMSE
	L11 N=20	L18 N=20	LCh11 N=20	LCh18 N=20	Reproductive Rhythm	Diet	RR x D	
Chicory intake (kg TQ)			60.3	60.3				
Total lactating diet intake (kg TQ)	54.3	53.42	52.6	53.97	0.5981	0.2742	0.0317	2.25

RMSE: Root Mean Square Error

CONCLUSIONS

The inclusion of fresh chicory in the diet determined a better reproductive performance in does submitted to the standard reproductive rhythm. The less effect of chicory inclusion in the semi-intensive group might be explained by the larger period of time between parturitions, that was enough to recuperate the body condition to confront a successive pregnancy and lactation cycle.

Dietary administration of fresh chicory improved milk production, independently from the reproductive rhythm increasing kit weight at weaning.

Does submitted to the standard reproductive rhythm and without chicory inclusion showed the poorest results, making evident the progressive reduction of body reserves to support the successive pregnancy/lactation, partially superpose.

REFERENCES

A.O.A.C. 1984. Official Methods of Analysis of the Association of Official Analytical Chemists. *14th Ed. Association of Official Analytical Chemists, Washington, DC, USA*.

Castellini C., Dal Bosco A., Cardinali R. 2006. Long term effect of post-weaning rhythm on the body fat and performance of rabbit doe. *Rep. Nutr. Dev., 46, 195-204.*

Castellini C., Dal Bosco A., Mugnai C. 2003. Effect of reproductive rhythm on the ovarian status and reproductive performance of rabbit does. *In: Proc. XV Congresso ASPA, Parma, Italy, 426-428*.

Dal Bosco A., Castellini C., Mugnai C. 2003. Evaluation of body condition in pregnant rabbit does by ultrasound scanner. *In: Proc. ASPA, 2003 June, Parma, Italy, 480-482*.

De Mayolas E. 2003. Conejos para Carne. *Ed. Hemisferio Sur, Buenos Aires, Argentina, 190 pp in pg. 47*.

Fortun-Lamothe L. 2006. Energy balance and reproductive performance in rabbit does. Review. *Animal Reproduction Science, 93, 1-15*.

Fortun L., Lebas F. 1994. Effets de l'origine et de la teneur en énergie de l'aliment sur les performances de reproduction de lapines primipares saillies post-partum. Premiers résultats *In*: *Proc. 6émes Journées de la Recherche Cunicole en France, La Rochelle, France, Vol. II, 285-292.*

Goering H., Van Soest P.J. 1970. Forage fiber analysis. *US Dep. Agric. Handb., 397*.

Maertens L., Aerts J.M., De Boever J. 2004. Degradation of dietary oligofructose and inulin in the gastro-intestinal tract of the rabbits and the effects on caecal pH and volatile fatty acids. *World Rabbit Science, 12, 235-246*.

Parigi Bini R., Xiccato G., Cinetto M. 1989. Influenza dell'intervallo parto-accoppiamento sulle prestazioni riproduttive delle coniglie fattrici. *Riv. Coniglicoltura, 26, 51-57*.

Parigi Bini R., Xiccato G., Dalle Zotte A., Carazzolo A., Castellini C., Stradaioli G. 1996. Effect of remating interval and diet on the performance and energy balance of rabbit does. *In*: *Proc 6th World Rabbit Congress, 1996 July, Toulouse, France, Vol. 1, 253-258.*

Xiccato G., Parigi-Bini R., Dalle Zotte A., Carazzolo A., Cossu M.E. 1995. Effect of dietary energy level, addition of fat and physiological state on performance and energy balance of lactating and pregnant rabbit does. *Anim. Sci., 61, 387-398*.

Van Loo J., Coussement P., De Leenheer L., Hoebregs H., Smits G. 1995. On the presence of inulin and oligofructose as natural ingredients in the western diet. *Crit. Rev. Food. Sci. Nutr., 35, 525-552*.